EVERYDAY ELECTRONICS

NOVEMBER 1991

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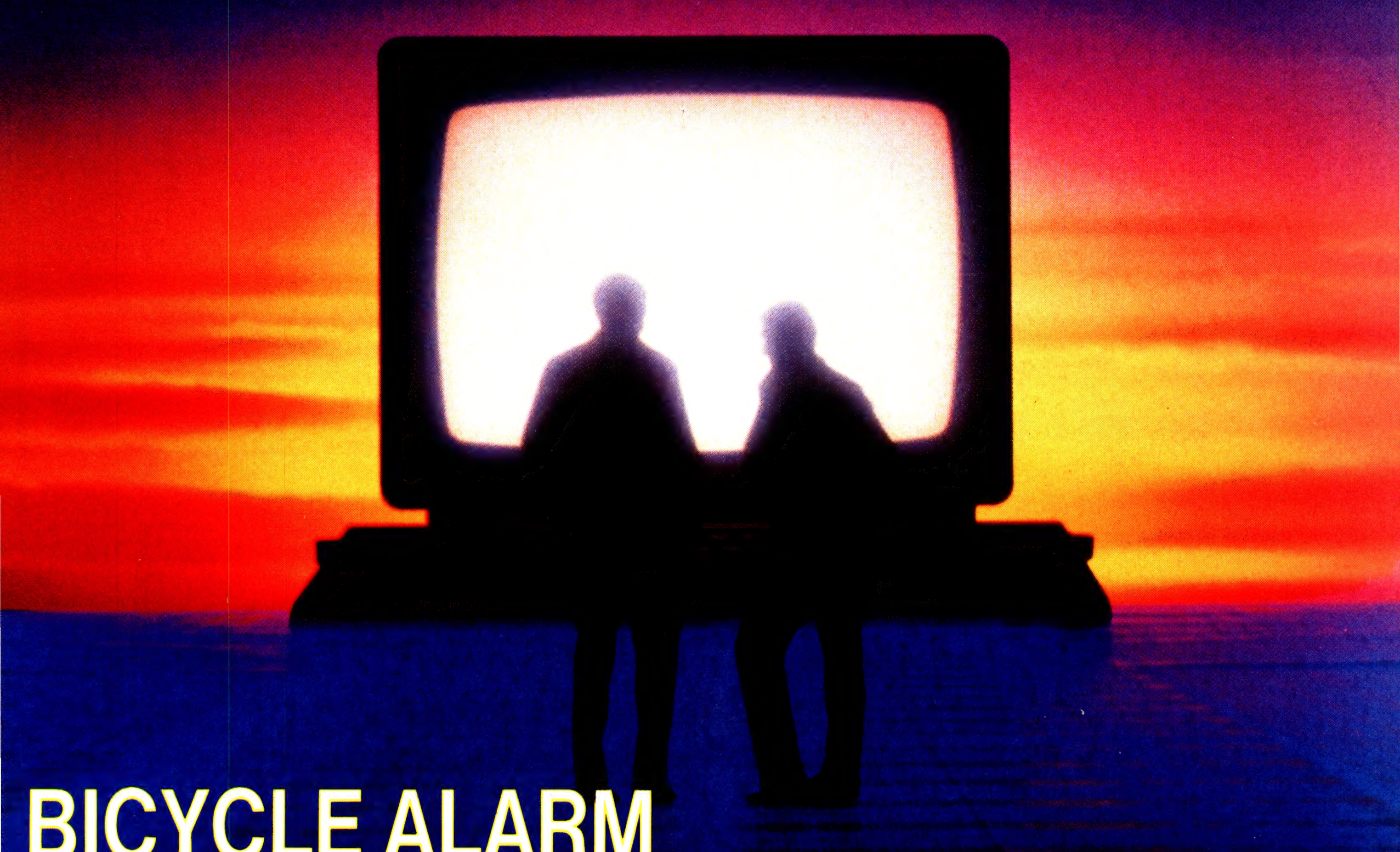

BICYCLE ALARM

New series

INFORMATION TECHNOLOGY AND THE NATIONAL CURRICULUM

FOR PARENTS, STUDENTS AND TEACHERS

The No. 1 Magazine for Electronics & Computer Projects

UNIDEN SATELLITE RECEIVER Brand new units (model 8008) £60.00 ref 60P4V also some 7007s also £60.00 ref 60P5V

SPECTRUM +2 COMPUTER Built in data recorder, 128K, psu and manuals £59.00 ref 59P4V

SPECTRUM +3 COMPUTER Built in disc drive, 128K, psu and manuals £79.00 ref 79P4V

AMSTRAD CPC464 COMPUTER No manuals but only £79.00 ref 79P5V

AMSTRAD CPC6128 COMPUTER Again no manuals but only £149.00 ref 149P4V

AMSTRAD GT65 Green screen monitor £49.00 ref 49P4V

AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD). £179 (PPC1512DD). £179 (PPC1640SD). £209 (PPC1640DD). MODEMS £30 EXTRA.NO MANUALS OR PSU.

AMSTRAD PC BARGAIN!!!!!!

PC 1512DD COMPLETE WITH CGA COLOUR MONITOR, 2 DISC DRIVES, MANUALS ETC ONLY £249.00 REF 249P4V

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7V.

2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93V

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18V

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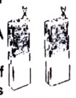
12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42V

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24V.

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43V

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39V Suitable mains adaptor £5.00 ref 5P191V

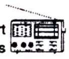
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2V



MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12V

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AV

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead **NOW ONLY £19.00!! REF 19P14V.**



WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179V.

CAR STEREO AND FM RADIO Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21V.

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50V

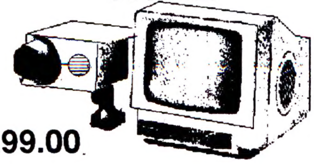
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14V.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44V. 2 x C's £4.00 ref 4P73V, 4 x D's £9.00 ref 9P12V, 1 x PP3 £6.00 ref 6P35V

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32V.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104V. Bumper pack of 1,000 ties £14.00 ref 14P6V

VIDEO AND AUDIO MONITORING SYSTEM



£99.00

Brand new units consisting of a camera, 14cm monitor, 70 metres of cable, AC adapter, mounting bracket and owners manual. 240v AC or 12v DC operation complete with built in 2 way intercom. **£99.00** ref 99P2v.

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1v

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158V

FM BUG Built and tested superior 9v operation £14.00 ref 14P3V

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39V.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22V.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8V.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21V.

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3V.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3V.

AT 286 MOTHER BOARD

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UPGRADABLE TO 4 M

AT CASE

AT POWER SUPPLY

AT KEYBOARD

MANUAL

NO I/O CARDS

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ELECTRONIC TICKET MACHINES These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28V.

JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174V.

GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas.£10.00 ref 10P130V

ANSWER MACHINES BTapproved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2V

CAR IONIZER KIT Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8V.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95V.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41V.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33V.

MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165V.

STC SWITCHED MODE POWER SUPPLY 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £6.00 ref 6P59V

HIGH RESOLUTION 12" AMBER MONITOR 12v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2V

VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4V

25 WATT STEREO AMPLIFIER c. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69V (Circuit dia included).

LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21V.

MAINS FANS Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166V.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2V.

MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716V.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26V.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92V, PACK OF 100 £30.00 REF 30P16V

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48V.

FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88V. Pack of 10 51/4" DSDD £5.00 ref 5P168V.

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SONIC CONTROLLED MOTOR One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137V.

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827V.

LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77V or 5 for £10.00 ref 10P78V.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81V.

100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107V.

TRANSMITTER RECEIVER SYSTEM originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26V

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc £4.00 each ref 4P82V.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194V.

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36V.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181V.

PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12V

ASTEC SWITCHED MODE POWER SUPPLY 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39V.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190V.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167V.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292V.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140V.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135V

POWERFUL SOLAR CELL 1AMP .45 VOLT only £5.00 ref 5P192V (other sizes avaliable in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51V.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170V.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286V.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287V.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92V.

LED PACK .50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52V

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6V.

ULTRASONIC WIRELESS ALARM SYSTEM Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34V. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6V.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18V.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186V.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62V or 2 sheets for £7.00 ref 7P22V.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352V.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2V

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109V.

SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364V

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91V

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365V

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366V

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362V.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205V

5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213V

ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207V

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10V

2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1V.

CUSTOMER RETURNED 2 channel full function radio controlled cars only £8.00 ref 8P200V

WINDUP SOLAR POWERED RADIO! FM/AM radio takes NICAD batteries complete with hand charger and solar panel 14P200V

240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40.00 ref 4υP200V

300 WATT RMS MONO AMP KIT £55.00 Psu required ref 55P200V

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200V

ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200V

35MM CAMERAS Customer returned units with built in flash and 28mm lens **2 for £8.00** ref 8P200V

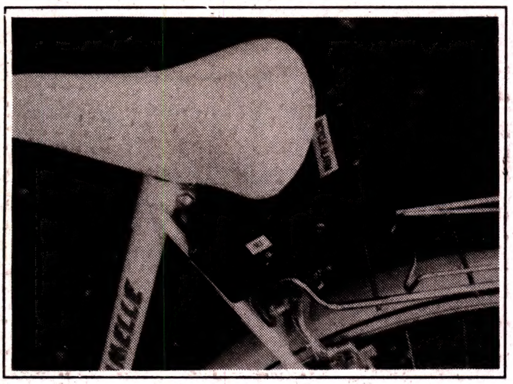
STEAM ENGINE Standard Mamod 1332 engine with boiler piston etc £30ref 30P200V

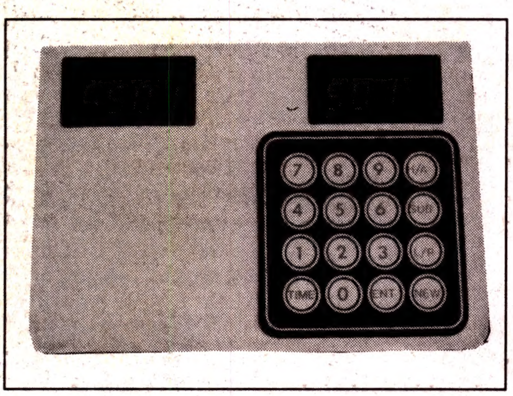
SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

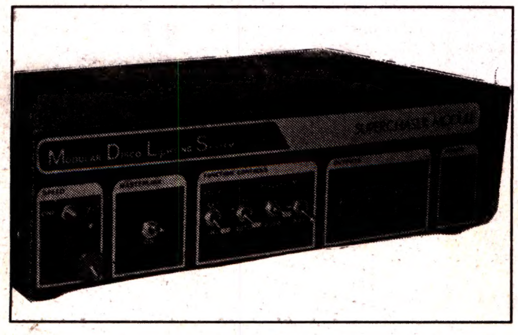
EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
ABC
VOL. 20 No. 11 NOVEMBER 1991
The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







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FREE WITH THIS ISSUE

GREENWELD ELECTRONIC COMPONENTS 1992 CATALOGUE **Banded to all copies**

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Our December '91 issue will be published on Friday, 1 November 1991. See page 683 for details.

Readers Services • Editorial and Advertisement Departments 691

HARD DISC DRIVES

20 Mb	(IDE - CONNER)	£ 79
20 Mb	(MFM or RLL)	£ 79
40 Mb	(IDE)	£ 140
40 Mb	(MFM)	£ 120
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MOUNTING KIT	(INCLUDING BEZELS & LED)	£ 9
MOUNTING KIT	(MOUNTING RAILS ONLY)	£ 5

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20 Mb	AT - IDE	£105
20 Mb	XT - IDE	£115
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40 Mb	XT - IDE	£180
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HARDCARD KIT

CONVERT YOUR 3½" HARD DISC DRIVE TO A HARDCARD.

PRICE £ 18

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AT 102 KEY - U K £24

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3½"	1.44M	INTERNAL	£ 45
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5¼"	1.2M	EXTERNAL	£ 52
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LONG F D D CONTROLLER CABLE 4'	£ 7.00
POWER SPLITTER	£ 4.50
HARD DRIVE CABLES (MFM/RLL)	£ 6.00
IDE HARD DRIVE CABLE (2 DRIVES)	£ 6.00
KEYBOARD EXTENSION CABLE	£ 4.00
MICRO 'T' SWITCH - RS232	£ 6.50

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WOULD YOU LIKE TO USE 1.2M OR 1.44M DRIVES ON YOUR COMPUTER. YOU CAN NOW WITH HOBBYKIT'S FLOPPY DISC CONTROLLER CARD. WILL ALLOW 2 EXTRA DRIVES OF ANY FORMAT IN YOUR COMPUTER

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IDE CARD	- 8 BIT-XT /AT / 1512	£ 29
AT RLL	- 2 x HDD	£ 25
AT MFM	- 2 x HDD / 2 x FDD	£ 48
AT RLL	- 2 x HDD / 2 x FDD	£ 40

MONITORS

14" VGA COLOUR 0.31 DOT PITCH
TILT & SWIVEL BASE £ 153

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★ COMPLETE WITH 1 Mb MEMORY ★

286 - 12	L/S 16 MHz	£ 97
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5¼" CASE ONLY	£ 10
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VGA CARD - 16 BIT - 256K	£ 39
TRIDENT SUPER VGA - 16BIT - 512K	£ 60
2 SERIAL / 1 PARALLEL / 1 GAMES PORT	£ 19
4 MB RAM CARD FOR AT WITH EMS USES 256K OR 1M - WITHOUT RAM	£ 57

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MODEMS - V22 BIS - 2400 BPS
AUTO DIAL - AUTO ANSWER - FULL DUPLEX
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MC2400 - INTERNAL	£ 65
SM2400 - EXTERNAL	£ 93

3½" - 720K EXT FLOPPY DISC DRIVE
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3½" - 1.44 M INT FLOPPY DISC DRIVE
BLACK ONLY
SPECIAL OFFER PRICE £ 39

5¼" - 360K INT FLOPPY DISC DRIVE
NEW - GREY OR BLACK
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CGA CARD - FULL LENGTH -
COMPOSITE & TTL £ 12

60 MEG TAPE STREAMER
DC600 - 5¼" TRAY
SUITABLE FOR ALL IBM COMPATIBLES
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WORDSTAR 2000 LAN VOL 1 & 2	£ 20
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SUPER CALC 4 LAN	£ 20
ABILITY PLUS	£ 30
PAYMASTER	£ 20
LINK MASTER	£ 20
SUPER CALC 2 FOR CP/M PLUS	£ 20
LOCOMAIL FOR PCW	£ 20

PLEASE ADD £ 3.00 TO ALL ORDERS TO COVER POSTAGE

NEXT MONTH

FREE INSIDE THE DECEMBER ISSUE

48 PAGE PULL-OUT GREENWELD BARGAIN LIST
A SUPPLEMENT TO THEIR CATALOGUE

MIND MACHINE

In September's "Brainwave" project, the design of a simple mind "entrainment" project was given, and the principles of this relaxation technique were described. Although an effective first project for newcomers to this field, the "Brainwave" was fairly simple, and a far more sophisticated instrument can be built. The next two articles in this series will cover the construction of an advanced version, combining "photic stimulation" and "binaural" sound, and having the option of a programmer so that users can experiment with various sequences.

SIGNAL GENERATOR

A number of low-frequency signal generator circuits using the 8038 function chip have been published but most of them show no particular regard to the accuracy either of frequency or output voltage levels. Since the 8038 still seems to be going strong in the integrated circuit world, here is a design which enables quantitative measurements to be made over the frequency range 0.1Hz to 100kHz with an accuracy better than 2% and an output level range from a maximum of 10V peak-to-peak to 40dB down.

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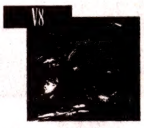

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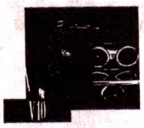

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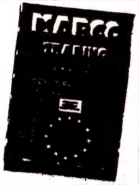

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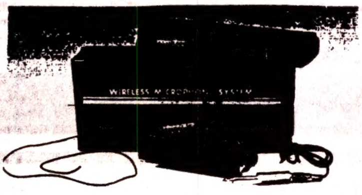

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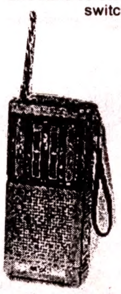

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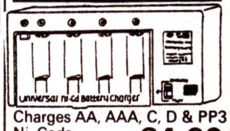

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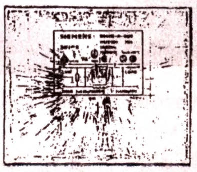

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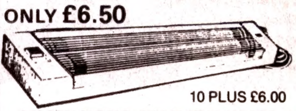

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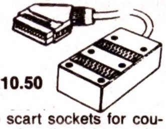

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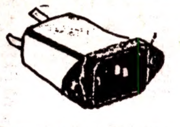

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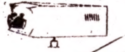

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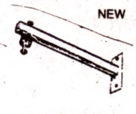

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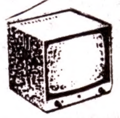

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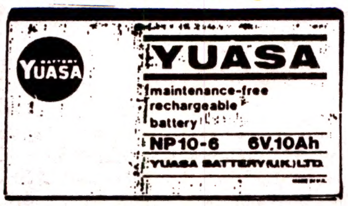

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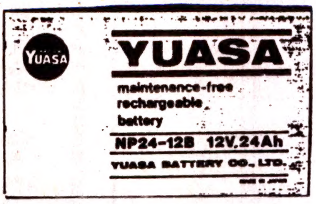

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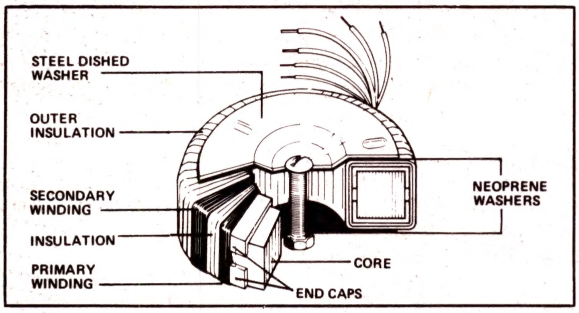

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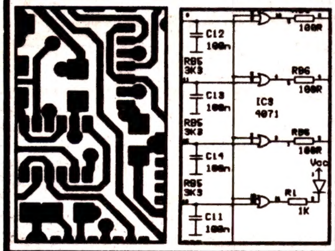

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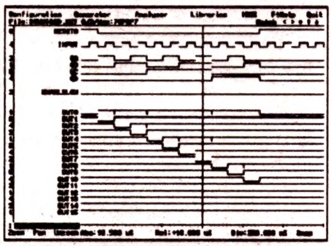

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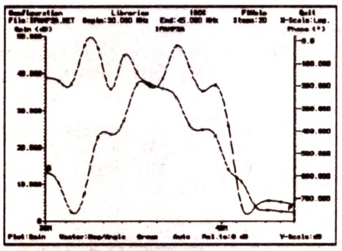

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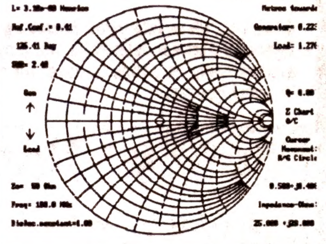

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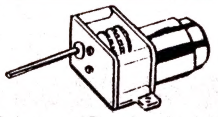

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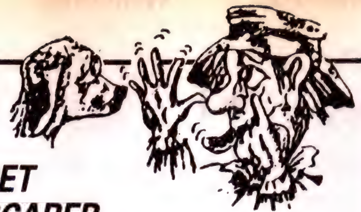

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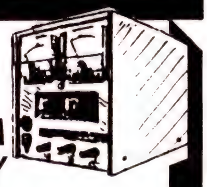

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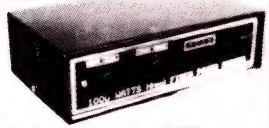

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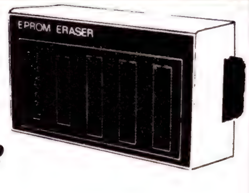

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PEN IN HAND

Nearly every month I sit down pen in hand – yes even with half a dozen PC's on the premises I still write my leader with a pen, then scratch it out and muck it about before Pam types it up, sorts out the spelling and the grammar before I re-read it and muck it about a bit more – now where was I?

Oh yes, I sit down pen in hand and scratch my head about just what to say. Should it be something topical like the effect of information technology on opinion polls and the possibility of a general election? Or maybe the changes to the National Curriculum for Information Technology that affect every student, plenty of teachers and should be of interest to all parents – see our new series starting in this issue.

Or something unusual or funny, like why in this day and age does the editor not type with more than one finger and still has not used Typefit, our typesetting software, even though it is employed by many of our advertisers and a local butcher! Or maybe it should be about something technically topical like the microprocessor based project that illustrates how complex tasks can be undertaken by relatively easy to build projects using dedicated m.p.u.s. and fairly complex interfacing/decoding/encoding chips – yes the *Darts Scorer* is a good project.

SO WHAT?

In the end it is often very difficult to decide what to say and sometimes all I have are ideas that fail to materialise into an interesting and enlightening piece – hence these three hundred odd words about little or nothing – sometimes it's just like that. I hope you don't feel too cheated?

Mike Kenward

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Constructional Project

BICYCLE ALARM

MAX HORSEY

Valuable bikes disappear everyday. This alarm may deter the casual thief and could save you a long walk home.

THIS Bicycle Alarm project has been designed for maximum ease of operation, and offers the following features:

- ★ **Alarm is set by a single toggle switch.**
- ★ **Alarm is reset by inserting a correctly wired jack plug, or keyswitch if preferred.**
- ★ **Alarm is triggered by a vibration switch.**
- ★ **Alarm sounds for only 10 seconds if knocked, or if the bicycle simply falls over.**
- ★ **Alarm sounds continuously if the bicycle is ridden.**
- ★ **Alarm sounds continuously if the wrong jack plug is inserted, or if the switch is turned off without inserting the plug.**
- ★ **No external wiring is necessary.**

The Bicycle Alarm is set by simply switching a toggle switch from "off" to "on". If the switch is returned to its off position the alarm will sound continuously. The user may only disarm the alarm by inserting a correctly wired jack plug, then switching the toggle switch to the Off position. The jack plug is then removed.

HOW IT WORKS

The block diagram for the Bicycle Alarm is shown in Fig. 1. The heart of the circuit is the monostable which acts as a timer. The numbers shown indicate the pins of the i.c. This enables a comparison to be made with the circuit diagram, Fig. 2.

Returning to Fig. 1, monostables require feedback of some kind to keep them latched for the time required. In this case the latch is taken from the output of an OR gate (actually made from diodes D1, D2 and D3).

The 3-input AND gate satisfies the condition that the monostable will be triggered if:

the switch S1 is ON (alarm set),
AND the vibration switch S1 is moved
AND the jack plug is NOT inserted,

If the correct jack plug is inserted the output from the AND gate will always be at logic 0 (about 0V). If the wrong type of plug is inserted, or a plug not wired as described later, either the AND gate will not be inhibited (i.e. it will continue to work), or the OR gate will be activated. In this case the monostable will latch with its output at logic 1.

The toggle switch S2 cannot be used to de-activate the alarm unless the jack plug is first inserted. If S2 is switched to "off" without inserting the jack plug it causes a negative pulse, via capacitor C1, which triggers the alarm.

A problem could arise here. After 10 seconds the alarm would stop sounding, and with S2 in the off position the alarm would not be triggered from the vibration switch. The inclusion of a 2-input AND gate solves the problem.

During the initial 10 seconds the output from the monostable is at logic 1. This, combined with the "off" setting of S2 causes the output from the AND gate to switch to logic 1. When fed via the OR gate, this keeps the siren sounding indefinitely. The 2-input AND gate is actually connected to the inverted output from the monostable, but since the logic is inverted again at the AND gate, the effect is as described.

In practice the monostable is ideally constructed using NOR gates, and to make full use of the four gates provided in a single i.c. the AND gates are also constructed from NOR gates. This simplifies the construction enormously and reduces the cost, but makes the circuit diagram look rather different to the block diagram!

CIRCUIT DESCRIPTION

The full circuit diagram for the Bicycle Alarm is shown in Fig. 2. When comparing Fig. 1 and Fig. 2 note that the two AND gates are made by using NOR gates with the input logic levels inverted. This avoids the need for using a second i.c. and simplifies the construction.

The block diagram shows a 3-input AND gate, but in the real circuit only 2-input gates are available. The AND condition between switches S1 and S2 is satisfied by connecting the switches in series. In other words when S2 is in the "on" position it connects with S1 which in turn is connected to input pin 2 of the gate IC1a.

Resistor R2 normally keeps pin 2 at logic 1, but if S1 is "on" AND vibration switch

This unit is attached to the bike frame with two Jubilee clips bolted to the case. This is the suggested position for the finished unit.

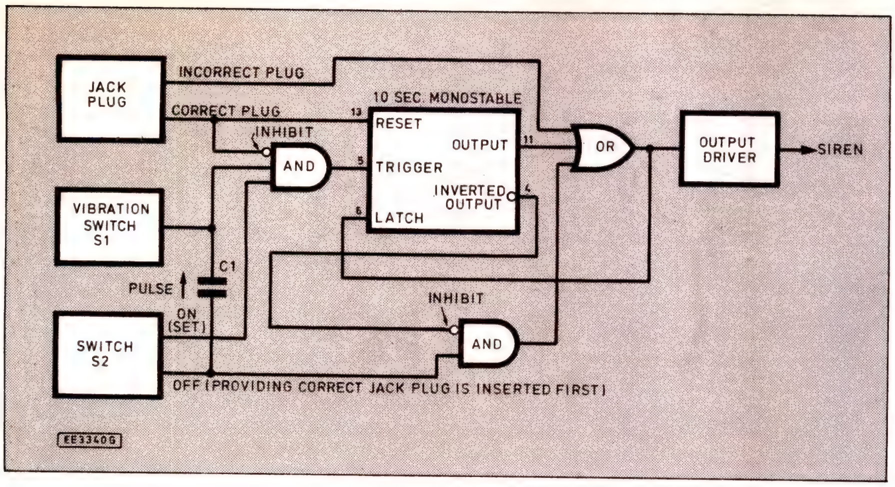


Fig. 1. Block diagram of the Bicycle Alarm.

COMPONENTS

Resistors

R1	1k
R2	100k
R3	1M
R4	470k
R5	2k2
R6	10k
R7	1k
R8	100k

All 0.25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	0µ1 poly or disc
C2	22µ radial elect. 25V
C3	47µ radial elect. 25V
C4	1000µ axial elect. 35V
C5	0µ1 poly or disc

Semiconductors

D1,D2, D3,D4	1N4148 signal diode (4 off)
D5	1N4001 1A 50V rec. diode
TR1	BC184L *npn* silicon transistor
IC1	4001B Quad 2-input NOR gate

Miscellaneous

WD1	12V high power buzzer
S1	Mercury vibrator switch
S2	Single-pole double throw' toggle switch

Plastic case, size 152mm x 102mm x 64mm; stereo jack socket (2.5mm or 3.5mm) and plug; Jubilee clips, to suit bicycle frame; eight AA cells and battery holder (8 x AA); connecting wire; solder, etc.

Printed circuit board available from *EE PCB Service*, code EE773

Approx cost guidance only **£12** *plus battery*

S1 is moved, pin 2 will briefly switch to logic 0. Assuming that the jack plug is NOT inserted, pin 1 will be held at logic 0 by resistor R1.

A glance at the NOR gate truth table (Fig. 3) will confirm that the output from pin 3 now switches to logic 1 each time pin 2 switches to logic 0. A single positive pulse (i.e. logic 1) from pin 3 will trigger the monostable.

The monostable is constructed from NOR gates IC1b and IC1c. Resistor R4 and capacitor C2 control the time period. If either are doubled in value, the time for which the alarm sounds will double.

The trigger input is pin five and a brief positive pulse here will cause the output pin 4 to switch from logic 1 (12V) to logic 0. This sudden change of voltage will be transferred via capacitor C2 to pin 12, making it also logic 0.

Assuming that the jack plug is NOT inserted, pin 13 will also be at logic 0, and output pin 11 will switch to logic 1. With pin 11 at logic 1, current will flow via resistors R5 and R7 to switch on transistor TR1 and activate the siren WD1.

The logic 1 from pin 11 will also feed back to pin 6, causing the monostable to remain latched in this state. With pin 12 at logic 0, a voltage difference exists across resistor R4, and current flows, slowly charging up capacitor C2. As the voltage on pin 12 rises to about 8V, pin 11 will switch back to logic 0, and the alarm will stop sounding. With the feedback action stopped the monostable will revert to its original condition with pin 4 at logic 1.

JACK PLUG

The diagram of SK1 refers to "Screen", "Right sound channel" and "Left sound channel" in a normal stereo jack plug. The circuit assumes that the screen terminal will be connected to the left using a piece of wire, and the right channel will remain unconnected.

If the correct jack plug is inserted, pin 1 of IC1a will be at logic 1 (high), and pin 3 will therefore remain at logic 0 (low) regardless of the level at pin 2. The alarm cannot now be triggered. If the alarm is already sounding when the plug is inserted, the change to logic 1 at pin 13 will force the monostable to reset.

If an incorrectly wired plug is used, then pin 1 and pin 13 may not switch to logic 1. Alternatively (particularly if a mono jack plug or a nail is used) the screen terminal will connect with the "right channel" and current will flow via diode D1 and resistor R6 causing the alarm to sound, and also latching the monostable. If the nail is withdrawn the alarm will reset after 10 seconds, but if the nail is left in place the alarm will sound continuously.

Whenever the correct jack plug is inserted or removed, the right channel will

INPUTS		OUTPUT
B	A	Q
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 3. NOR gate truth table.

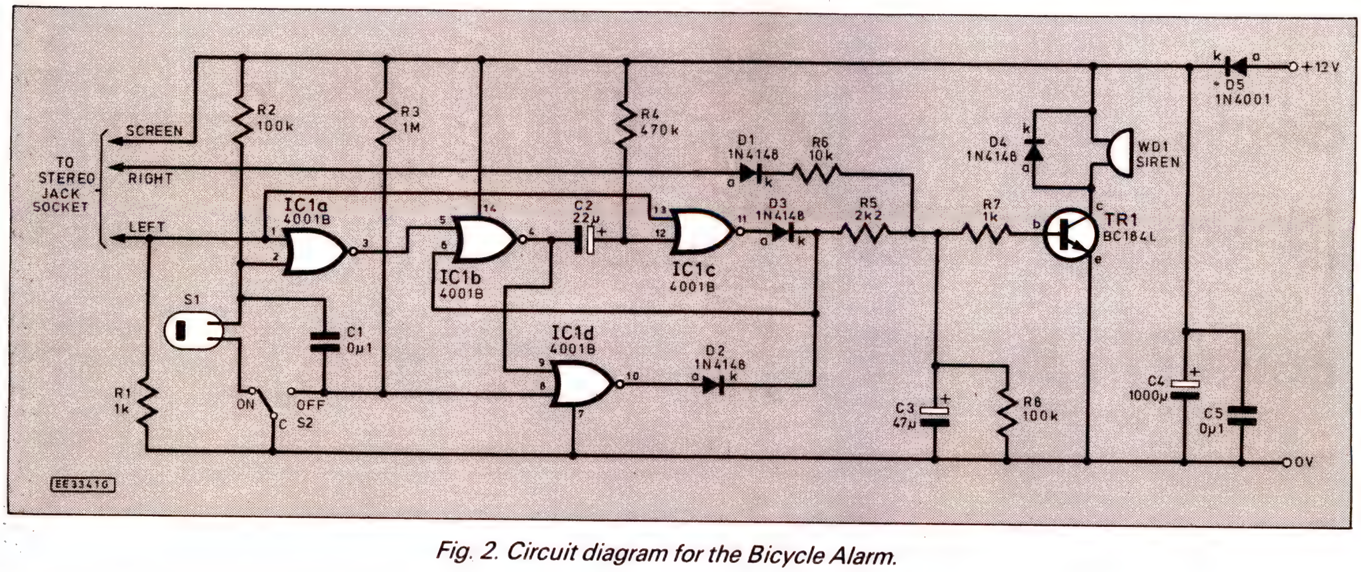


Fig. 2. Circuit diagram for the Bicycle Alarm.

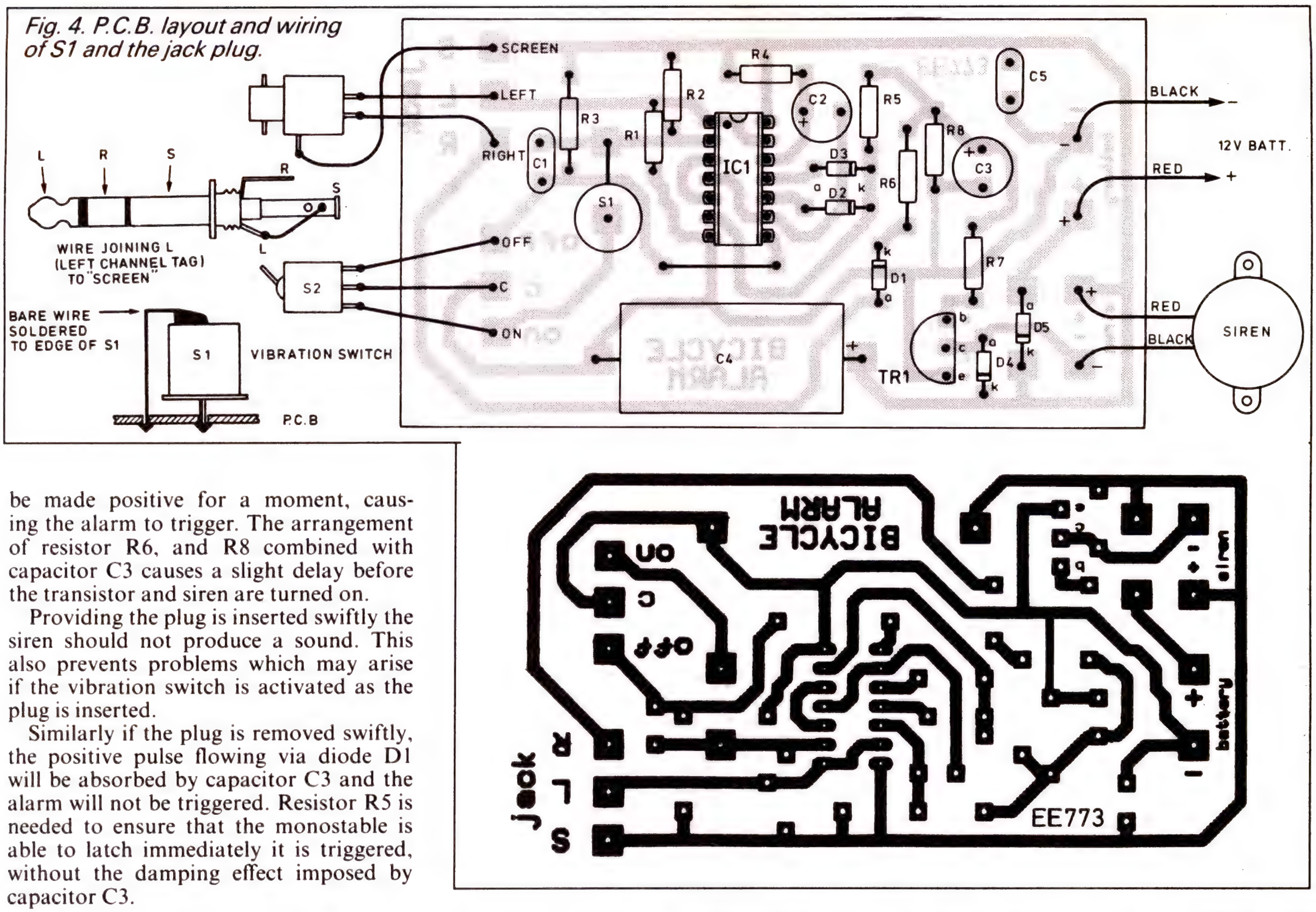


Fig. 4. P.C.B. layout and wiring of S1 and the jack plug.

be made positive for a moment, causing the alarm to trigger. The arrangement of resistor R6, and R8 combined with capacitor C3 causes a slight delay before the transistor and siren are turned on.

Providing the plug is inserted swiftly the siren should not produce a sound. This also prevents problems which may arise if the vibration switch is activated as the plug is inserted.

Similarly if the plug is removed swiftly, the positive pulse flowing via diode D1 will be absorbed by capacitor C3 and the alarm will not be triggered. Resistor R5 is needed to ensure that the monostable is able to latch immediately it is triggered, without the damping effect imposed by capacitor C3.

TOGGLE SWITCH

The toggle switch S2 is used to set the alarm as described. When switching off the alarm the jack plug must *first* be inserted. This prevents any negative (logic 0) pulses from S1 or C1 having any affect on IC1a gate output.

If the jack plug is not inserted, and assuming that S2 is in the On position the alarm will trigger when the bicycle is moved as described earlier. If S2 is moved to the Off position a negative pulse will flow via capacitor C1, and this will activate the alarm as if the bicycle had been moved. Returning S2 to the On position will allow the monostable to complete its time period, but it will re-trigger if the bicycle is moved.

Leaving S2 in its Off position will cause the alarm to sound continuously. This is achieved by means of gate IC1d. When the alarm is sounding, pin 4 of the monostable is at logic 0, and hence pin 9 of IC1d will be at logic 0.

When S2 is off, pin 8 will also be at logic 0. Output pin 10 will therefore switch to logic 1, and current will flow through diode D2, resistors R5 and R7, causing the transistor and siren to switch on. Pin 6 of the monostable will also rise to logic 1 causing the monostable to latch. The alarm will sound continuously even after pin 11 has switched back to logic 0, to prevent a potential thief from stealing the bicycle after the 10 second time period.

OUTPUT STAGE

The transistor TR1 increases the current available up to about 100mA. If a siren is used which requires a larger current, the existing siren may be replaced by a relay, and the larger siren driven from the relay's switch contacts. Diode D4 prevents any damage which may occur to the transistor by back e.m.f. from the siren or relay.

Diode D5 is included to prevent damage if the battery is connected the wrong way round, and capacitor C4 and C5 decouple the circuit, to provide a smooth power supply.

ALTERNATIVES

Assuming that the jack plug is kept on a key ring, it is convenient to remove it from the socket immediately S2 is switched to its Off position. It is possible to leave the jack plug in its socket whenever the alarm is not active, but a larger than desired current will be drawn continuously via resistor R1.

A low value of one kilohm is indicated for resistor R1 to assure reliable operation, if for example the jack socket becomes damp. However, any person wishing to leave the jack plug in the socket for long periods could increase R1 to say 100k.

KEYSWITCH

The jack plug and socket could be replaced by a keyswitch, in which case the connections labelled *Screen* and *Left* should be arranged so that they are "closed" (connected together) when the alarm is to be turned off, and "open" when the alarm is set. Connection *Right* should be ignored.

When de-activating the alarm, the keyswitch should be moved to its closed position, then switch S2 switched off, before returning the key switch back to open. If the keyswitch is left in its closed position the problem will be similar to that of leaving the jack plug in its socket, described in the previous paragraphs.

The keyswitch could be connected in series with the battery if preferred. Unless two lines of defence are required, the jack plug and socket could be omitted, and switch S2 could also be omitted, with a wire link joining the pads labelled "ON" and "C" on the printed circuit board.

CURRENT CONSUMPTION

When the jack plug is not inserted, and switch S2 is set to On, virtually no current will flow from the battery unless the alarm is triggered. When riding the bicycle, S2 will be set to Off, and a current of about 12 micro-amps will flow through resistor R3. The battery life should be about a year.

CONSTRUCTION

Construction of the alarm is relatively straightforward with most of the components mounted on a printed circuit board (p.c.b.) as shown in Fig. 4. This board is available from the *EE PCB Service*, code EE773.

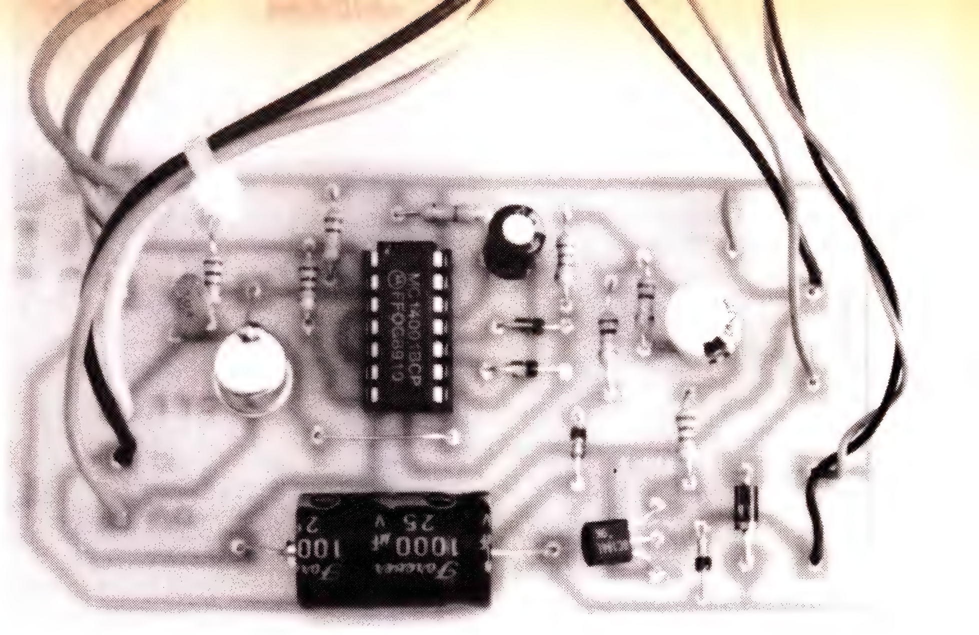
Begin construction by fitting the socket for IC1; followed by the wire link, resistors, and capacitors C1 and C5. The diodes and capacitors C2, C3 and C4 *must* be fitted the correct way round, as must the BC184L transistor.

The mercury filled vibration switch S1 is normally supplied with a single rather stout wire, which should be pushed into the pad as indicated. The other connection is via the case of S1, and this is achieved by soldering a bare wire into the other pad as shown, then soldering the other end of the wire to the edge of the switch metal case.

This may appear difficult, and it is wise to coat the corner of the case with a little solder prior to joining the wire. Press the soldering iron firmly against the case until the solder melts into place, since a larger than normal amount of heat will be needed to make a sound joining. *Do not* *leave the soldering iron on the case any longer than absolutely necessary.*

The toggle switch S2 should be connected via flexible leads as shown, ensuring that they are long enough to allow S2 to be mounted in the case. Similarly the stereo jack socket SK1 should be connected, ensuring it is wired exactly as in the diagram. Finally connect the siren and battery holder checking that the red and black leads are round the correct way in both cases.

The stereo jack plug "key" should be "coded" by soldering a short wire from the small tag nearest the centre, to the longest metal tag as shown. If in doubt check that you have joined the tip of the plug to the longest metal section.



TESTING

Do not insert the key jack plug, but set S2 to Off. Connect the batteries. The alarm should not sound, even if the "vibration" switch S1 is jolted.

Now set S2 to On. The siren should not sound unless the p.c.b. (and hence S1) is jotted. Now knock the p.c.b. to make the siren sound. Check that the siren stops sounding after about 10 seconds. Now set S2 to Off. The siren should sound continuously. Set S2 back to On and allow the siren to stop sounding again.

Insert the correctly wired key jack plug. It should now be possible to set S2 to Off without triggering the siren.

Set S2 to On again, and insert a mono jack plug or join points *Screen* and *right* on the p.c.b. The siren should start again.

FAULT FINDING

If after carefully checking the completed p.c.b. for track "shorts", and making sure that all polarity dependent components have been wired in correctly, the unit still fails to function as it should the following procedure should be adopted.

Many people find jack plugs and sockets confusing, and if in doubt it might be worth disconnecting the jack socket, and simulating the effect of the plug by joining pad *Screen* to pad *Left* to represent the plug pushed in. Likewise, leaving all three pads unconnected represents the plug pulled out.

To check that the siren works (regardless of anything else), the collector (c) lead of the transistor (which leads to the siren) can be joined briefly to the emitter (which leads to 0V) using a small piece of wire. *Take care not to touch the base lead by mistake.* If the siren works, try joining the junction of resistors R5, R6, R7 and capacitor C3 directly to the positive supply. If the siren works, then at least the output section of the circuit is working properly.

Assuming that the circuit fails to work or the siren sounds continuously (which is even more annoying), check the voltage across pin 14 (positive) and pin 7 (0V) of IC1. It should be about 12V.

Now connect the negative (black) lead of a voltmeter (multimeter) to 0V in the circuit (the negative side of capacitor C4 is a useful place for attaching leads). Use the positive voltmeter (red) lead as a probe, touching various points in the circuit in order to identify the area of trouble.

The pins of IC1 make useful test points. The following table refers to "*hi*", meaning more than 9V, and "*lo*", meaning less than 2V. Remember that the pin numbers count up from pin 1 (top left, near the notch or dot) to pin 7 (bottom left), then pin 8 (bottom right), to pin 14 (top right).

When the jack plug is out, and S2 is On.

Check that pin 1 and pin 13 are *lo*
Check that pin 4 is *hi*

Wait for at least 10 seconds, then check switch S1.

Check that pin 4 is *lo* (measure within 10 secs of knock)
Check that pin 9 copies pin 4
Check that pin 11 is *hi* for about 10 secs after the knock, then returns *lo*.
Check that the junction of D2, D3, and R5 is *hi* when pin 11 is *hi*.
Check that pin 6 copies this junction.

If the siren sounds continuously, wait at least 15 secs, then without knocking S1.

Check that both sides of D1 are *lo*
Check that both sides of D3 are *lo*
Check pins 4:*hi*, 6:*lo*, 9:*hi*, 10:*lo*, 11:*lo*

When the jack plug is inserted, but S2 remains On. Check pins 1:*hi*, 3:*lo*, 4:*hi*, 5:*lo*, 6:*lo*, 9:*hi*, 10:*lo*, 11:*lo*, 13*hi*

Now move S2 to Off.

All readings should be unchanged and pin 8 should be 0V.

No readings are quoted for pin 8 (when *hi*) and pin 12, since only voltmeters with a very high resistance will provide accurate results.

CASE

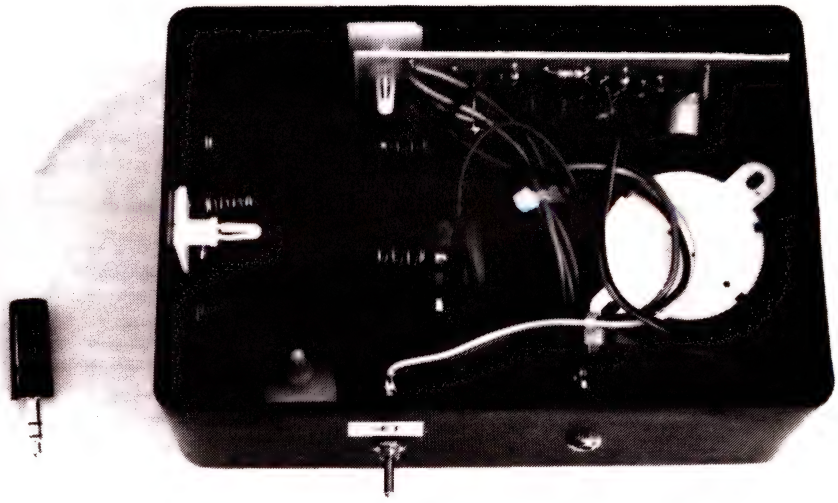
A case measuring 152mm by 102mm by 64mm was used in the prototype. Begin by drilling holes for the jack socket, switch S2 and a hole for the sound produced by the siren.

At an early stage it is wise to check the method of securing the case to the bicycle. In the prototype, Jubilee clips were used to fasten round the two supports just below the saddle, see photographs. The case should be mounted so that water is unlikely to drip through any holes in the case – particularly the one drilled for the siren.

The p.c.b. is mounted vertically using one of the slots in the end of the case and a self-adhesive stand-off support at the other end of the p.c.b. The 12V battery box is also held in position by means of self-adhesive supports, and a piece of foam glued to the lid of the case. The siren was glued to the bottom of the case, upside-down so that the sound could escape through the hole drilled in the bottom of case.

Finally secure the jack socket and toggle switch, and insert the batteries. A final test should be made before securing the lid.

The alarm may now be mounted on the bicycle in any convenient place. The struts just below the saddle are suggested since this area tends to be shielded from rain, and the alarm will be less noticeable. ☐



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DARTS SCORER

RICHARD STONE

Don't let the lack of mental dexterity spoil your game. This scorer will keep count for you and give you the time when not in use.

THIS article describes the design and construction of a microprocessor controlled Electronic Darts Scorer similar in specification and performance to commercially available units. The Darts Scorer has the following features :-

☆ Players scores displayed on individual 3-digit l.e.d. displays.

☆ Home and Away players scores entered via common keypad.

☆ Facility to recall previously entered score.

☆ Individual start scores can be entered for each player (to allow handicapping).

☆ Correction facility available for incorrectly entered scores.

☆ Functions as a digital clock when not being used for darts. Low power consumption components used wherever possible.

☆ Straightforward construction.

☆ Free-standing or wall mounted.

The construction of this unit should give the reader a useful insight into the design and construction of a typical 'embedded' microprocessor application.

DESIGN OVERVIEW

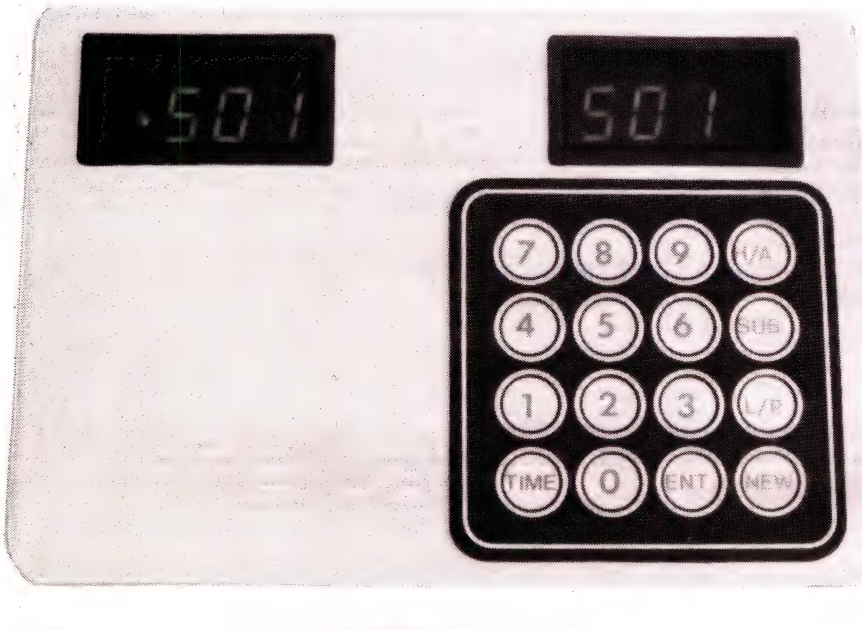
A simplified block diagram of the Darts Scorer is given in Fig. 1. The heart of the system is a simple microcomputer built around the Motorola MC146805E2 microprocessor.

The microprocessor reads program instructions contained in a ROM (Read Only Memory) and then executes these instructions in order to perform the functions of the Darts Scorer.

User input is via a 16 key keypad which is continually scanned for a keypress by a dedicated keypad encoder chip. Detected keypresses are input to the microprocessor and appropriate action taken upon them under program control.

Output to the user is via a six digit multiplexed l.e.d. display. The microprocessor continually updates the display at a frequency greater than the persistence of vision and hence the display appears continuous to the user.

A full circuit diagram of the unit is given in Fig. 2 and this should be referred to when reading the following text which gives a detailed description of the circuit design.



MICROPROCESSOR AND SUPPORT CIRCUITRY

The microcomputer which provides the 'control' element for the Darts Scorer is based around the Motorola MC146805E2 8-bit microprocessor (MPU) chip (IC1). This chip is a member of the MC6805 microcomputer family but has an external bus interface allowing it to access up to 8K of external memory. The chip is highly integrated and contains 112 bytes of internal RAM (Random Access or Read/Write Memory),internal programmable timer,sixteen programmable I/O lines and on-chip oscillator circuitry.

In order to allow the chip to be packaged in a standard 40 pin d.i.l. package,the 8-bit data bus (D0-D7) and lower order address lines (A0-A7) are multiplexed and hence require to be de-multiplexed in order to work with ordinary non-multiplexed memory chips. The bus timing for the 146805E2 is shown in Fig. 3.

Five clock periods are used per bus cycle. The lower order address signals,provided by IC1,appear in the first part of the cycle and are qualified by the falling edge of AS (Address Strobe). A 74HC573 octal latch (IC4) is used to latch the lower order address lines. The outputs of this chip (Q0-Q7) follow the inputs (D0-D7) exactly providing that the LE (Latch Enable) input is high.

A falling edge at LE latches the outputs to retain the data that was set up at the inputs. On the Darts Scorer LE is connected directly to the AS output of IC1 and hence the lower order address lines are latched by the falling edge of AS as per the timing diagram. The 74HC573 is functionally identical to the more common 74HC373 but has a bus orientated pinout.

The Q0-Q7 outputs of IC4 which contain the de-multiplexed lower order address lines from the microprocessor are connected directly to the corresponding address inputs of the 27C64 EPROM (IC3). Non-multiplexed address outputs A8-A11 from the microprocessor are connected directly to the corresponding inputs of the EPROM.

The EPROM used in the Darts Scorer is a 27C64 which is an 8K device although the code occupies only just over 2K of the available 8K and was originally written

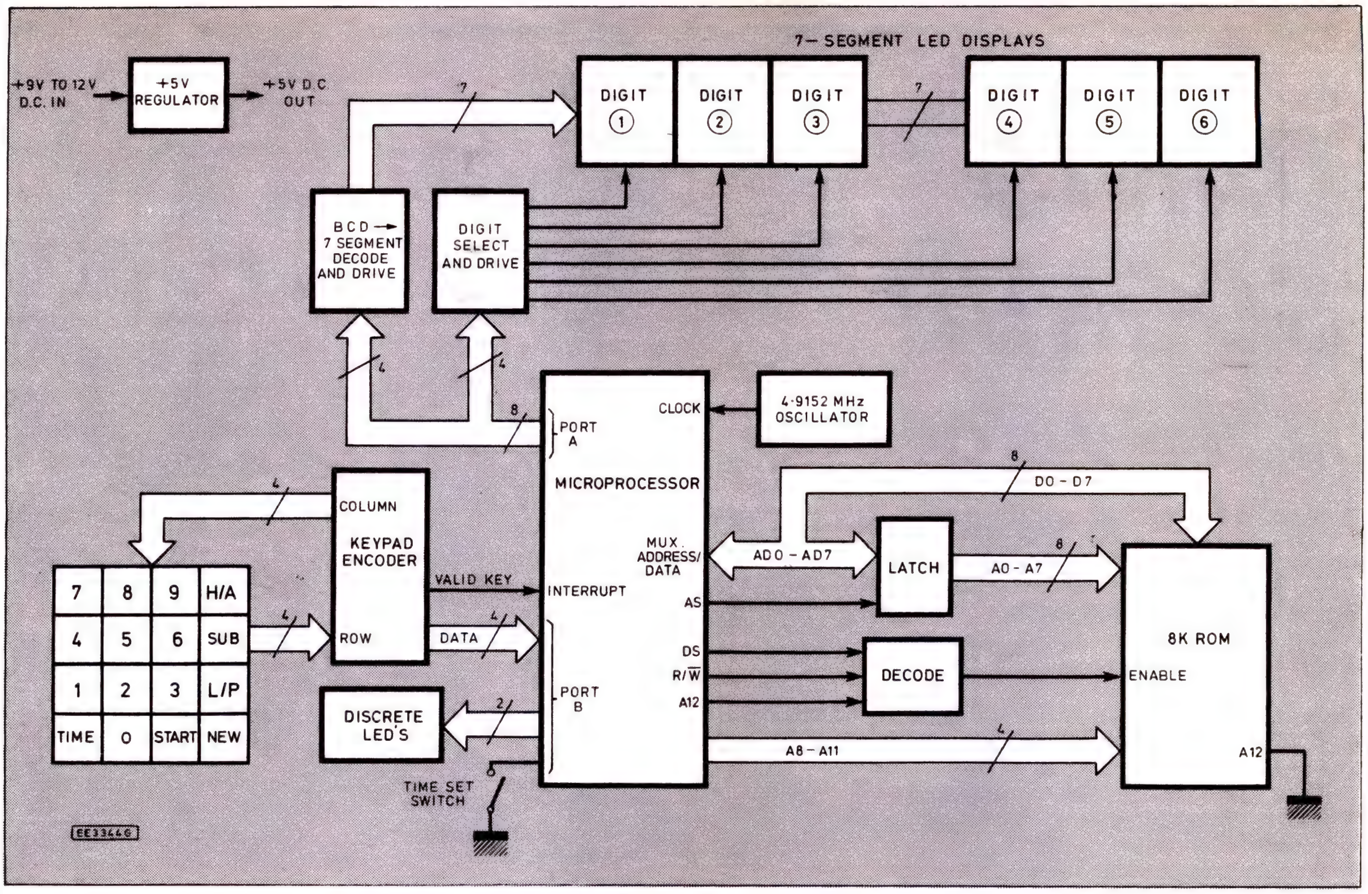


Fig. 1. Block diagram of the Darts Scorer.

to reside within a 27C32 (4K device). The reason for using a 27C64 is that as memory chips increase in capacity the smaller devices become less popular and hence more expensive. Address input A12 of the EPROM is tied to 0V and hence only the lower 4K of memory is accessible by the microprocessor.

The 27C64 CE* (Chip Enable) and OE* (Output Enable) inputs are tied together and connected to the output of a 3 input NAND gate (IC8a). The output of this gate will only go low, and hence enable the EPROM, when all of the gate inputs are simultaneously high. The gate inputs are A12, R/W* (Read/Write*) and DS (Data Strobe) which are all outputs from the microprocessor. The R/W* output from IC1 is used to indicate the direction of data transfer between the microprocessor and external devices and is high for a read cycle and low for a write cycle.

DS occurs anytime the microprocessor does a read or write cycle and is used to latch (on it's falling edge) data into the microprocessor from the multiplexed address/data bus during read cycles. This is important because the tri-state data lines of the EPROM (D0-D7) are connected to the corresponding multiplexed address/data bus pins of the microprocessor (IC1). This method of enabling the EPROM means that it can only be accessed during bus read cycles to the upper 4K of memory (1000_{HEX} to $1FFF_{HEX}$). It is important that the EPROM resides in the upper part of the addressing range as the microprocessor reset and interrupt vectors must be stored in ROM between addresses $1FF6_{HEX}$ and $1FFF_{HEX}$. A memory map of the 8K address range of the microprocessor is given in Fig. 4.

A crystal circuit comprising of a 4·9152 MHz parallel resonant crystal X1, R18, C4 and C5 is used to generate the fundamental clock signal for the microprocessor. This circuit makes use of the internal oscillator circuitry connected between OSC1 and OSC2. Although the maximum clock frequency of the 146805E2 is 5MHz, a frequency of 4·9152 MHz was chosen as this can be divided down, using the internal timer, to give an exact divisor of one second which is used as the basis of the real time clock feature of the Darts Scorer.

The 146805E2 resets itself automatically on power-up using internal circuitry. Resis-

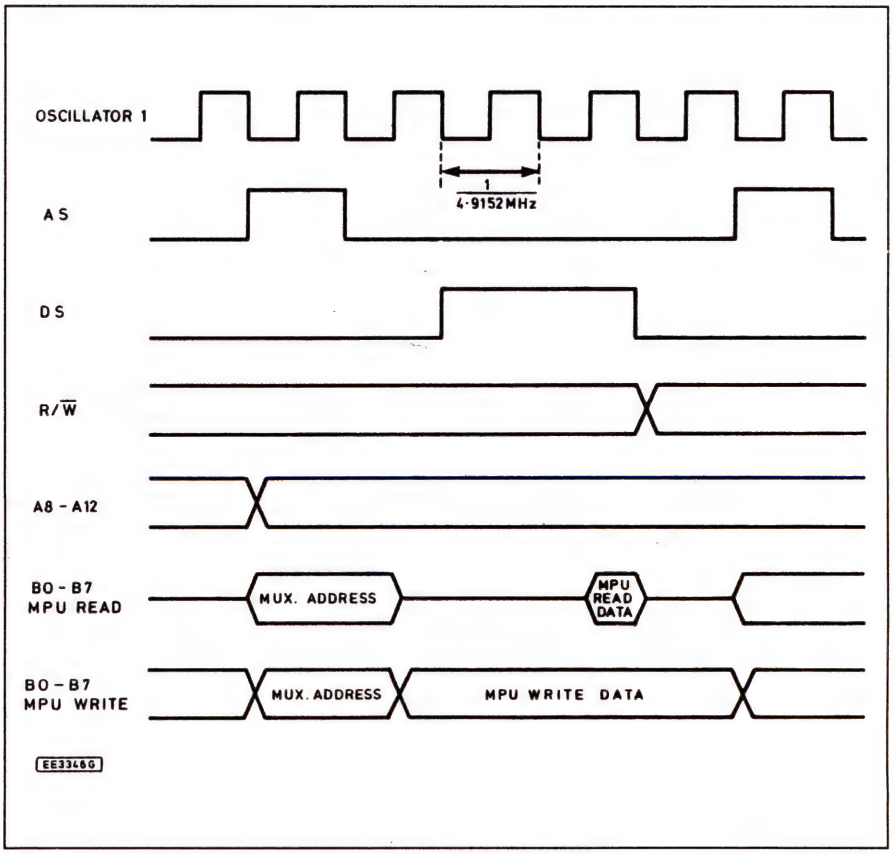


Fig. 3. Bus timing diagram for the MC146805E2.

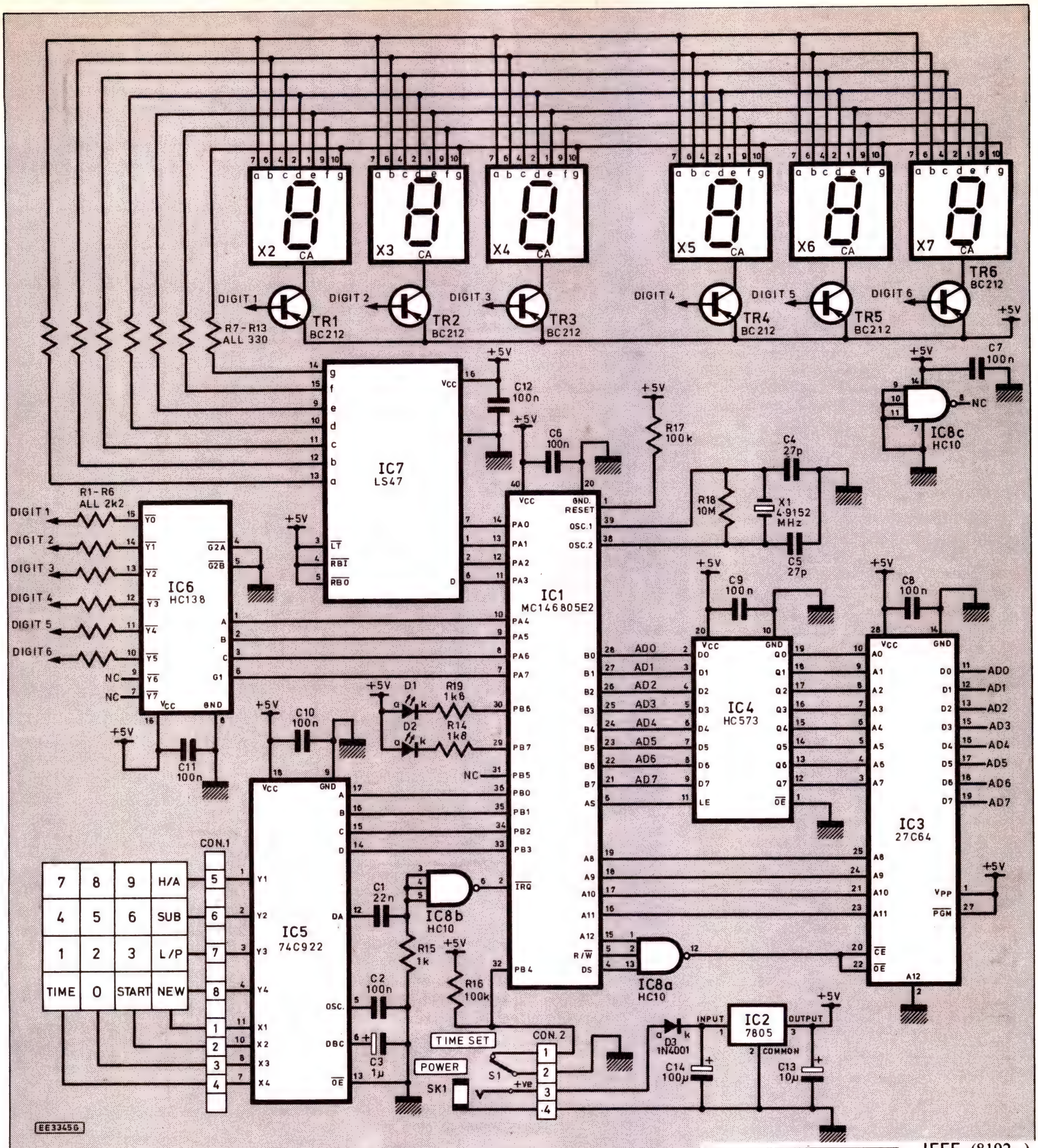


Fig. 2. Circuit diagram of the Darts Scorer.

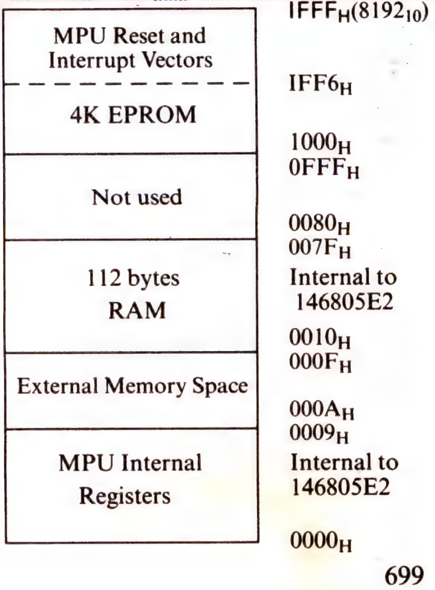


Fig. 4. (right) Memory map (not to scale).

tor R17 ensures that the external Reset input on the microprocessor is pulled up to + 5V and hence is inactive.

MULTIPLEXED DISPLAY

The six 7-segment l.e.d. displays (X2 to X7) used to output information on the Darts Scorer are driven in a multiplexed arrangement under the software control of the microprocessor. Multiplexing of 7-segment l.e.d. displays involves bussing together all the alike segment inputs of each digit which are then driven by a common segment driver. Each 7-segment display is provided with an individual digit driver which when switched on will cause the relevant segments (determined by which segment drivers are switched on) to be illuminated on the selected digit.

When driving the multiplexed display the segment drivers required to display a particular character are first switched on and then the digit driver, for the required digit, is switched on for a short period. The segment drivers are then set up to display the character for the next digit in the display and then the digit driver for that digit is switched on for a short period. This process continues until all the digits in the display have been updated and then the process repeats itself.

In order to maintain a bright, flicker free, display the display updating operation must be continuous and the length of time required to update all the displays must be shorter than the persistence of vision of the human eye. This equates to a required display update frequency of 50Hz or greater.

The display updating on the Darts Scorer is performed by a continuous software loop which outputs the required information to external segment and digit drivers via I/O Port A of the microprocessor. The two 8-bit I/O ports of the 146805E2, referred to as Port A and Port B, can be configured by the software as inputs, outputs or any mixture of the two. In this application Port A is configured entirely as outputs.

The segment drive function is performed by a 74LS47 BCD to 7-segment encoder/driver (IC7). This chip converts a 4-bit BCD (Binary Coded Decimal) input to the corresponding 7-segment code. The segment drivers provided on this chip are open-collector which means that common anode type displays must be used.

DIGIT DRIVERS

The digit drivers are discrete *pnp* transistors (TR1-TR6). Discrete transistors are used because in the worst case (all segments on) each transistor must switch a current of 70mA. Each digit drive transistor is switched on (conducting) or off (non-conducting) by an active low output of a 74HC138 3 to 8 line decoder chip (IC6). A three bit binary code on the inputs of this chip will cause the corresponding Y output to switch to a low level which will switch the corresponding digit drive transistor on. The remaining Y outputs of the chip remain in the high state and hence all the other digit drive transistors are switched off.

As mentioned earlier, both the 74LS47 (IC7) and the 74HC138 (IC6) are controlled by Port A of the microprocessor. The lower order 4 bits (PA0-PA3) are connected to the data inputs of IC7 and contain the numeric value of the character to be displayed in BCD format. Bits PA4-PA6 are connected to the address inputs of IC6 and are used to select the required digit. PA8 is used to enable/disable IC6. A low level on PA8 will disable IC6 and cause all the Y outputs to remain high regardless of the address input state. The software for the Darts Scorer continually outputs to Port A the correct data to continuously update the multiplexed display in the required manner.

If an illegal BCD bit pattern is presented to the 74LS47 (IC7), i.e. $>9_{DEC}$, then it outputs non numeric segment patterns (for inputs of 10_{DEC} – 14_{DEC}) or turns all segments off (for an input of 15_{DEC}). This feature is used to provide the cursor symbol used in the clock and also to suppress leading zeros in the display.

Multiplexing numeric l.e.d. displays has several advantages compared with driving the displays directly. Some of these are:-

(i) less hardware is required. Direct drive requires a separate decoder/driver for each digit.

(ii) less interconnections are required.

(iii) l.e.d.s are more efficient (i.e. give out more light) if they are pulsed with current rather then driven with a steady current, for the same average value of current.

The main disadvantage of microprocessor driven display multiplexing is that as the display requires constant updating, this places a significant overhead on processor time. This however is not a major problem on the Darts Scorer as the microprocessor spends the vast majority of the time waiting to service interrupts (either external or timer) and hence can handle the display updating as a background task.

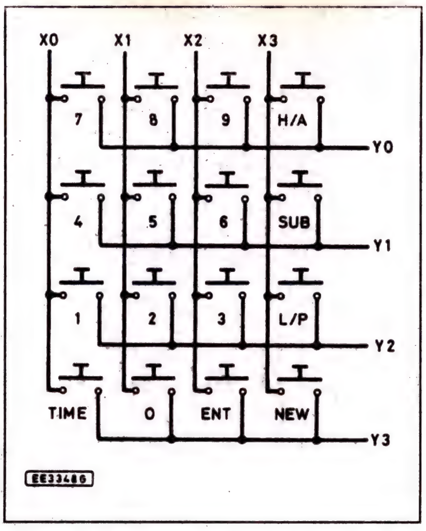


Fig. 5. Keypad switch layout.

KEYPAD ENCODING AND INTERRUPT

User input to the Darts Scorer is via a 16 key keypad through which all the functions of the Darts Scorer can be controlled. The membrane type keypad used has the 16 individual switches arranged in the common four by four matrix arrangement.

Pressing a particular key will short out the corresponding row and column at the switch intersection point. This is illustrated in Fig. 5. A 74C922 16 key keypad encoder chip (IC5) is used to convert this row and column information into a 4-bit code corresponding to the key pressed. This can then be directly read by the microprocessor using part of I/O Port B.

The keypad matrix is continually scanned by IC5 to detect a keypress. The scan frequency is set by an external capacitor (C2) and is set at 650Hz. Once a keypress has been detected it is "debounced" for a period of 10 mS, set by C3, to eliminate the problem of multiple keypresses being detected due to contact bounce. If the keypress is still valid after the debounce period then the DA (Data Available) output goes high. At this time the unique 4-bit code corresponding to the key pressed is available on the data outputs (D0-D3) which are connected to Port B inputs PB0-PB3.

The external interrupt input (IRQ*) on the microprocessor is used to signal to the microprocessor that a valid keypress requires attention. A negative going edge or a low level on this pin will cause the microprocessor to finish executing its current instruction and then vector to the external interrupt service routine. After this routine has been completed then normal program execution resumes from the same point at which the interrupt occured. However if, after execution of the external interrupt service, the level at the IRQ* pin is still low then the external interrupt service routine is executed again.

On the Darts Scorer it is important that each keypress is only seen once by the microprocessor This is accomplished by converting the rising edge of the DA output of IC5 to a narrow negative going pulse of approximately 30μS in duration. This is performed by using C1,R15 and IC8b connected as a positive edge triggered negative going pulse generator.

COMPONENTS

Resistors

R1 to R6	2k2 (6 off)
R7 to R13	330 (7 off)
R14,R19	1k8 (2 off)
R15	1k
R16,R17	100k (2 off)
R18	10M

All 0.25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	22n disc ceramic
C2	100n disc ceramic
C3	1μ elect. 10V
C4,C5	27p ceramic (2 off)
C6 to C12	100n disc ceramic (7 off)
C13	10μ elect. 10V
C14	100μ elect. 16V

Semiconductors

IC1	MC146805E2P 8-bit microprocessor
IC2	7805 +5V voltage regulator
IC3	27C64 8K byte CMOS EPROM – See Shop Talk
IC4	74HC573 Octal latch
IC5	74C922 Keypad encoder
IC6	74HC138 3:8 line decoder
IC7	74LS47 7 segment display encoder
IC8	74HC10 Triple 3 I/P NAND gate
D3	1N4001
TR1 to TR6	BC212 (6 off)
D1, D2	5mm low current red l.e.d. (2 off)
X2 to X7	0.56 inch low current common anode, 7 segment l.e.d. display (6 off)

Miscellaneous

X1	4·9152MHz crystal
SK1	3.5mm jack socket
S1	SPCO slide switch
CON1	8 way 0.1 inch R/A p.c.b. header plug and socket
CON2	4-way 0.1 inch pitch p.c.b. terminal block

16 key membrane keypad; APPOLO case; display bezel (2 off); 20mm spacer (4 off); M2 CSK screw (2 off); M3 CSK screw (4 off); wire, solder etc. PCB available from the *EE PCB Service*, order code EE774.

Approx cost guidance only **£60** *plus case*

When DA goes high the voltage on C1 becomes +5V and the output of IC8b, which is connected as an inverter, switches to 0V. C1 then discharges through R15 with a time constant of C1R15. As the decaying voltage passes through the switching threshold of IC8b the output of this switches high again. In this way a narrow negative going pulse is presented to the IRQ* input of the microprocessor. As the external interrupt service routine takes longer than 30μS to execute then the IRQ* input will have returned high before the interrupt service routine is completed. Hence the microprocessor is interrupted only once per keypress.

The 74C922 also provides two key rollover protection between any two switches. This means that if a new key is pressed before the previous key is released that, once the first key has been released, then the DA output will go low and then return high, after a normal debounce, to indicate acceptance of the second key. If two key rollover were not provided then the second keypress would not be seen by the microprocessor.

DISCRETE L.E.D.S

Two l.e.d.s, D1 and D2, are used on the Darts Scorer to indicate which player has control of the shared keypad. These are driven by I/O lines PB6 and PB7 respectively. A low output at the port pin will illuminate the l.e.d.

The l.e.d.s used are "low current" types as the microprocessor output port cannot supply enough current to drive conventional types directly. Resistors R14 and R19 limit the current sunk by the port outputs to 1.6mA.

TIME SET MODE SWITCH

A switch (S1) is provided on the Darts Scorer in order to allow the user to enter the correct time for the real time clock. This switch is connected to PB4 which is configured by the system as an input.

When the switch is open circuit the level at PB4 is +5V due to pull-up resistor R16. However when the switch is short circuit the level at PB4 is 0V. These different states are interpreted by the software to decide whether the Darts Scorer is to operate in "normal" or "time set" mode.

SUPPLY

The Darts Scorer is intended to operate from an external "plug top" mains adaptor which is capable of supplying +9V to +12V d.c. at 250mA. The input to the Darts Scorer (SK1) is via a 3.5mm jack socket wired in the tip +ve configuration. A diode D3 protects the circuit against an inadvertent wrong polarity connection.

The input d.c. voltage is smoothed by C14 and then fed to a 7805 series regulator (IC2). This provides a regulated +5V output which is used to power the rest of the circuit. The +5V supply is decoupled by capacitor C13. Each i.c. package is further decoupled by 100n capacitors, C7 to C12.

SOFTWARE

The control software for the Darts Scorer is too involved to describe fully in this article. However the three major functional blocks of the software have been illustrated in flowchart form in Fig. 6. These are the main display driving routine (Fig. 6a), the external (keypress) interrupt service routine (Fig. 6b) and the timer interrupt service routine (Fig. 6c).

MULTIPLEXED DISPLAY DRIVING ROUTINE

The main display driving routine is entered after the power-up system initialisation has taken place. The function of this routine is to drive the display hardware in the manner described earlier. On power-up the displays will show the default start score value of 501.

During operation of the Darts Scorer the displays can show either the last score entered, present score left to obtain or the current time depending on which keypad operations have taken place. Six bytes of the internal RAM of the microprocessor are used to store the character (in BCD format) for each of the 7-segment displays. Depending on which mode the Darts Scorer is operating in, the software moves the necessary information into these six bytes of display RAM.

The display driving software then accesses this RAM in order to obtain the character for each display. Leading zero suppression is also performed on the contents of the display RAM. If leading zeroes are found in the display RAM then they are replaced by the BCD code for 15_{DEC}. When this is output to the segment driver chip (IC7) it causes all segments to be switched off and hence the digit will be blank.

The display driving routine is continuous but it can be temporarily halted so that either a keypress (external) interrupt or an internal timer interrupt can be serviced. As either of these interrupts takes less than 0.1mS to execute there is no perceivable discontinuity in the display.

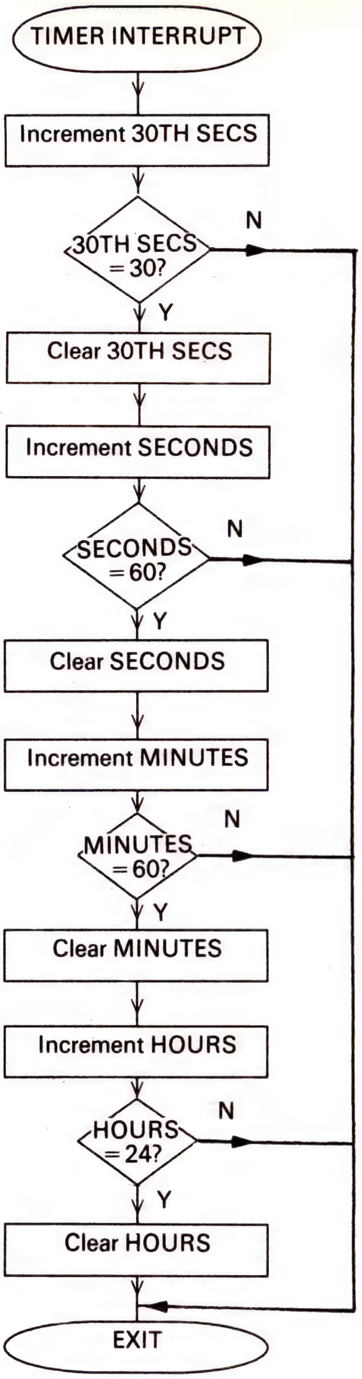


Fig. 6(c) Flow chart of timer interrupt (real time clock) service routine

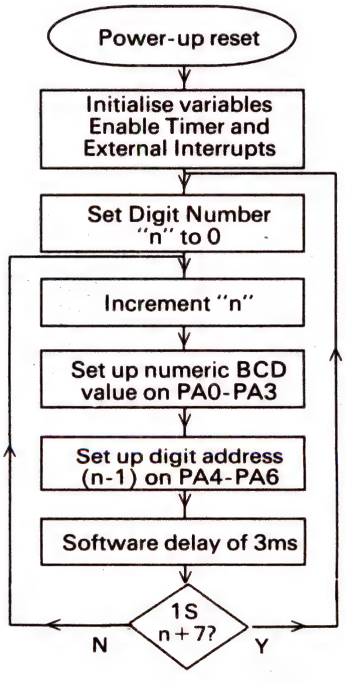

Power-up reset
Initialise variables Enable Timer and External Interrupts
Set Digit Number "n" to 0
Increment "n"
Set up numeric BCD value on PA0-PA3
Set up digit address (n-1) on PA4-PA6
Software delay of 3ms
IS n+7?
N
Y

Fig. 6(a) Flow chart of background multiplexed display driving routine

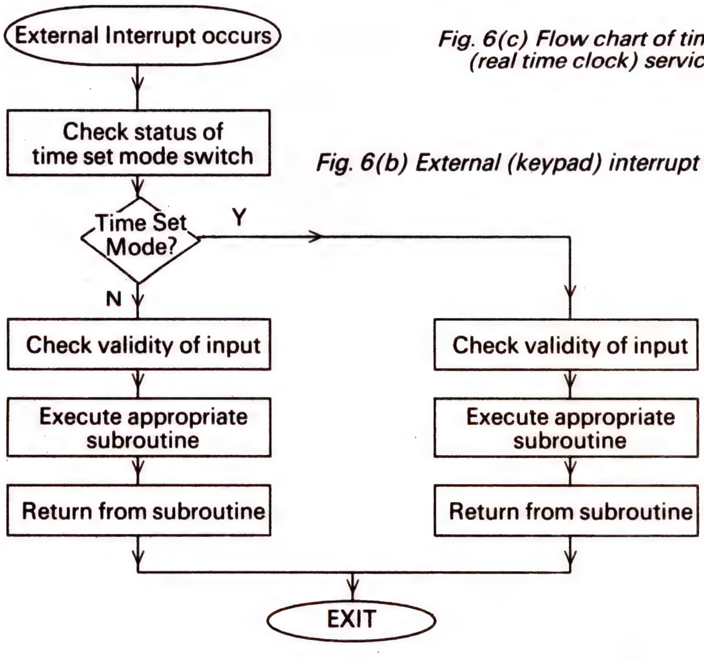

External Interrupt occurs
Check status of time set mode switch
Time Set Mode?
Y
N
Check validity of input
Execute appropriate subroutine
Return from subroutine
Check validity of input
Execute appropriate subroutine
Return from subroutine
EXIT

Fig. 6(b) External (keypad) interrupt routine flow chart

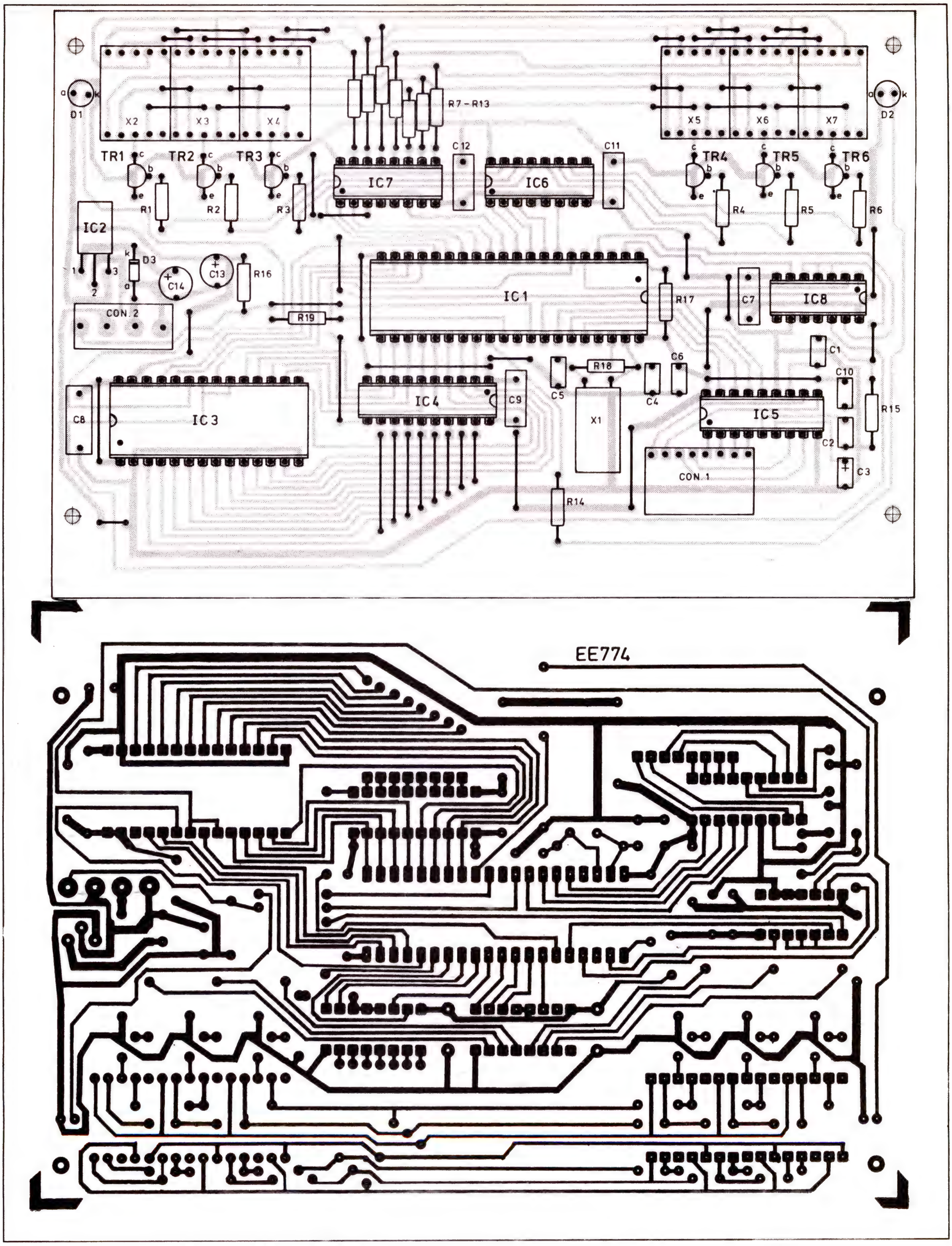
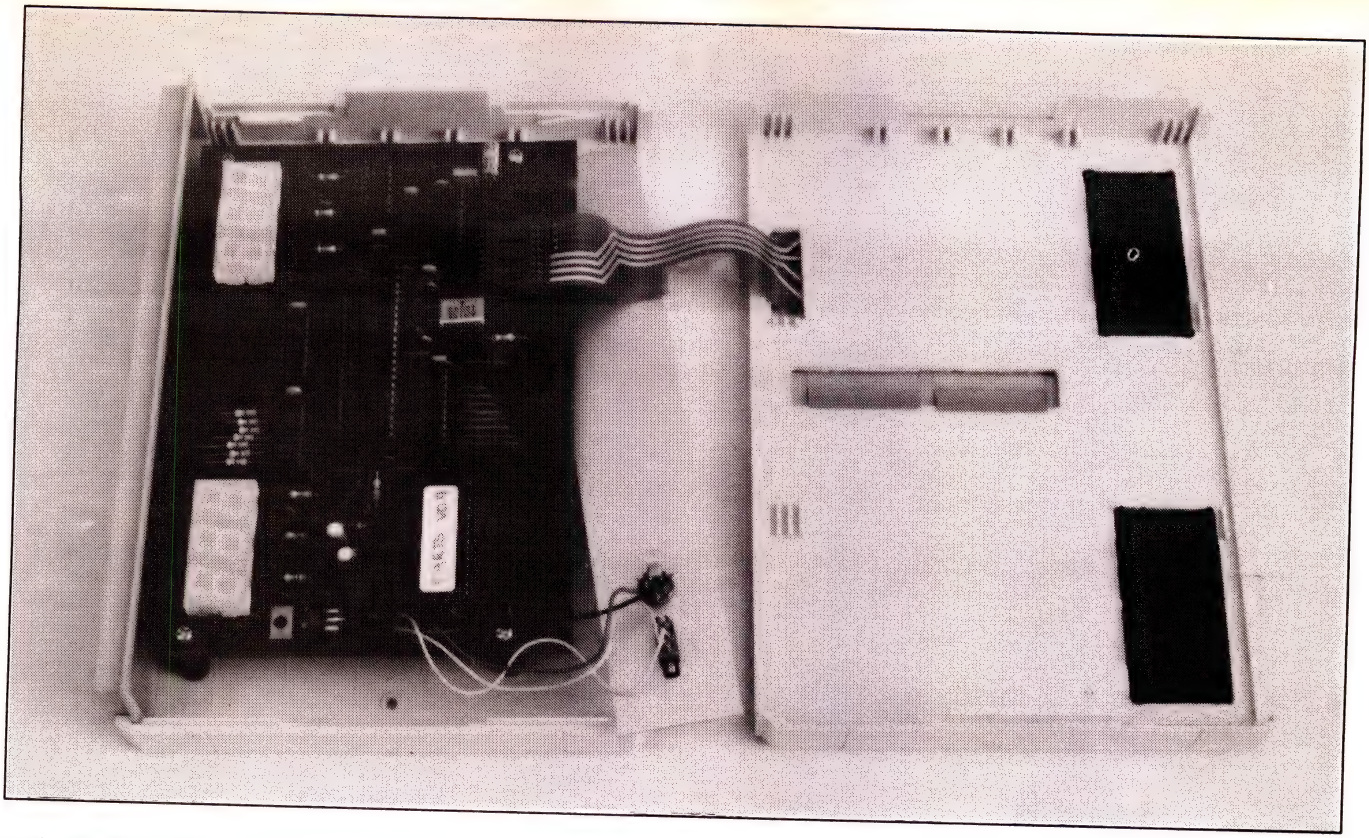


Fig. 7. P.C.B. master and wiring.

EXTERNAL INTERRUPT SERVICE ROUTINE

Each time a valid keypress occurs the external interrupt service routine is executed. The first action is to determine the status of the time set mode switch. The routine then branches depending on whether the Darts Scorer is in "time set" or "normal" mode. In each branch the keypress value is determined and checked for validity.

For example if the L/P key has been pressed once in order to display the last scores entered for each player, then the software will disregard all other key presses until L/P is pressed again to restore the present scores to the display. Once the validity of the keypress has been established a subroutine is then executed in order to implement the function required by the keypress. On completion of this subroutine the interrupt service routine is exited and the microprocessor returns back



to the display driving routine and continues to execute it from the point it was at before the interrupt occured.

TIMER INTERRUPT AND REAL TIME CLOCK

During the initialisation stage of the main program the microprocessor internal timer is configured to time out and generate a timer interrupt 30 times a second. This is accomplished by dividing the internal clock frequency which is 983040Hz (4·9152MHz/5) by 2_{15} (i.e. 32768) using the internal timer to give the required 30Hz timer interrupt frequency.

The purpose of the 30Hz timer interrupt is to provide the "tick" for the software controlled real time clock. As the software to provide this function is very simple it is included within the timer interrupt service routine. The routine, shown in Fig. 6c, uses four variables which are stored in the microprocessor internal RAM. These are named 30THSEC, SECONDS, MINUTES and HOURS.

On each occasion the timer interrupt is serviced the variable 30THSEC is incremented by one. If this incremented value is less than 30 then the routine is exited. However if 30THSEC is equal to 30 it means that one seconds worth of time has elapsed and so SECONDS is incremented by one and 30THSEC reset back to zero.

If the incremented value of seconds is less than 60 then the routine is exited. If SECONDS is equal to 60 this signifies that a minute has elapsed and so MINUTES is incremented by one and SECONDS reset back to zero. A similar process occurs with the MINUTES and HOURS variables.

The clock works in 24 hour mode *only* so all variables are reset back to zero when the HOURS count reaches 24. As the "tick" for the clock is derived from a crystal controlled oscillator the clock exhibits a high degree of accuracy.

CONSTRUCTION AND TESTING

The Darts Scorer was designed to be a self contained unit requiring only an external "plug top" transformer to operate. All components with the exception of the keypad, 3.5mm jack socket (SK1) and "time set" mode switch (S1) are mounted on a single p.c.b.. The p.c.b. is itself mounted in the Darts Scorer case such that the l.e.d. displays are visible through bezels mounted in the upper surface of the case.

The keypad is also mounted on the upper surface of the case and connects to the p.c.b. via an 8 way header plug. Connections to SK1 and S1 which are mounted on the aluminium side panel of the case, are via flying leads.

PCB ASSEMBLY

All of the components for the Darts Scorer with the exception of SK1 and S1 are mounted on a single sided p.c.b. The master artwork for the p.c.b. is given in Fig. 7.

Assembly of the components onto the p.c.b. is relatively straight forward but it is recommended that the following sequence is adhered to :-

Firstly, before beginning assembly, the p.c.b. should be inspected to ensure that all holes are drilled and clear. Next fit all the wire links using tinned copper wire of an appropriate gauge. There are a total of 47 of these (as the board is single sided) so care should be taken not to omit any. Ten of the wire links are fitted underneath where the 7-segment displays will be fitted so these should be fitted as flush to the upper surface of the p.c.b. as possible.

The resistors, R1 to R18, and diode D3 can be fitted next. The orientation of the resistors is unimportant but the diode must be fitted the correct way round. The cathode of the diode is usually indicated by a band on the component body at the relevant end.

The i.c. sockets can now be fitted. Although i.c. sockets are not strictly essential it is recomended that they are used. The sockets will be marked to indicate orientation and this should be carefully checked against Fig. 7.

The next stage is to fit transistors TR1 to TR6 and the voltage regulator IC2. The leads on all these devices should be carefully formed to match the relevant holes in the p.c.b.

The capacitors C1 to C14 and crystal X1 should now be fitted. Capacitors C3, C13 and C14 are polarised types so this should be observed when placing them on the p.c.b.

The next stage is to fit discrete l.e.d.s, D1 and D2, and the 7-segment displays X2 to X7. Orientation is important with all these components. The cathode on the discrete l.e.d.s will be indicated by a flat on the body of the component. The 7-segment displays should be orientated such that the decimal point is at the bottom right hand corner. As the 7-segment displays are fitted over some wire links they should be fitted to the p.c.b. such that the body of the component is approximately 1mm clear of the upper surface of the p.c.b.

The final stage is to fit the 8-way s.i.l. header, CON.1 and the 4-way terminal block CON.2.

DARTS SCORER CASE

The case used for the Darts Scorer is from the BICC-Vero 'APOLLO' range. It consists of two clip together halves, which form the front and rear of the Darts Scorer, and two side panels.

The front panel should be marked out as in Fig. 9. and the shaded areas removed by chain drilling and filing.

The rear panel should have the four holes drilled in it as shown in Fig. 9. These holes are used to secure the p.c.b. mounting pillars which are supplied with cheese head machine screws. In order to allow a flush rear panel countersunk head screws are used instead to fasten the pillars to the rear

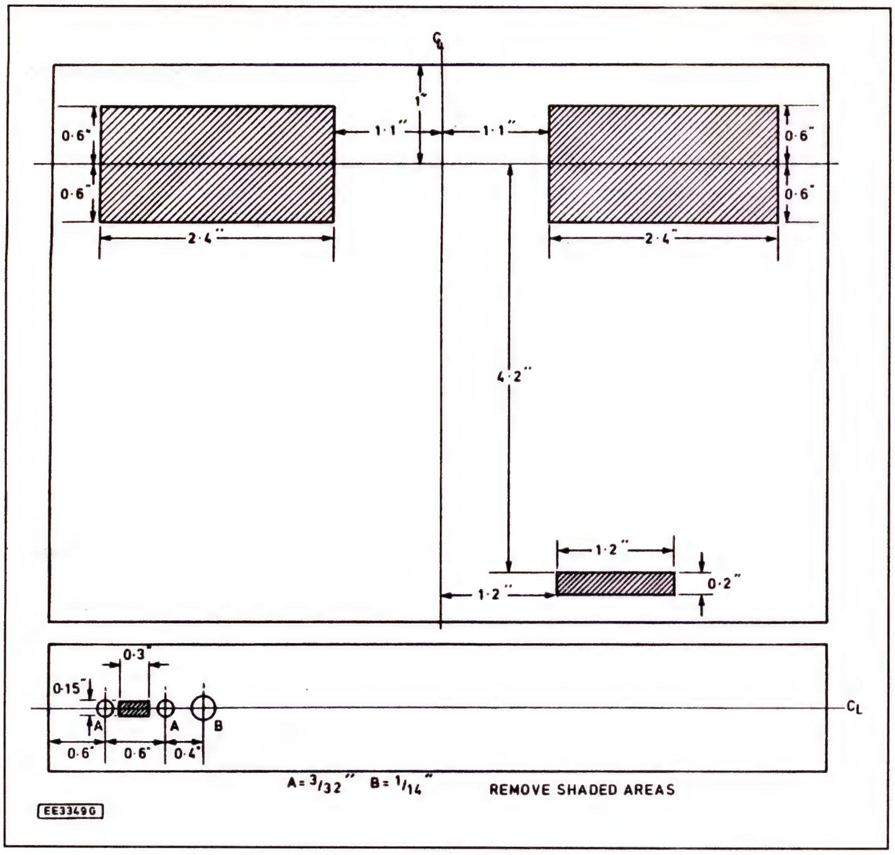


Fig. 8. Front panel and side panel cutting and drilling.

panel. Consequently the four holes should be contersunk to suit the screws used.

If wall mounting of the Darts Scorer is required then two "keyhole" slots should also be drilled and filed out. The centres for these "keyholes" are moulded onto the inner face of the rear panel, the actual dimensions of the "keyhole" will depend on the screw sizes used to fix the unit to a wall.

The aluminium side panel should also be marked out as shown in Fig. 8. and drilled and filed in order to accept the switch and jack socket.

ASSEMBLY OF UNIT

Before the unit is assembled it is necessary to fix the keypad and display bezels to the front panel and S1 and SK1 to the aluminium side panel. The display bezels are supplied with the outer moulding and the filter separate. The filter has a protective film covering which should be removed before the filter is carefully pressed into the slots in the outer moulding.

The bezels are a press fit in their respective cutouts but it may be necessary to retain them with a small amount of plastic glue applied sparingly.

Before the keypad is fixed to the front panel it is necessary to apply the appropriate legends to the insert sheets. The keypad is supplied with two altenative pairs of inserts and the pair with the "arrow" keys and "CLR" and "ENT" marked on them should be used.

The non-numeric keys will need changing to show the Darts Scorer functions. This was done on the prototype by applying rub-down transfers to white adhesive labels to form the appropriate legends and then sticking these over the supplied legends. Spray on varnish was then used to protect the rub-down transfers. Once this has been done then the legend sheets can be inserted in the slots in the back of the keypad. The keypad is fastened to the front panel with its self adhesive backing. The lower edge of the keypad is aligned with the lower edge of the front panel and the left hand edge is aligned with the "centre-line" of the front panel.

The power socket, SK1, is inserted through the hole in the aluminium side panel and secured with the locking ring nut.

The switch, S1, is fastened to the rear of the panel using two M2 countersunk screws which are inserted through the front panel. Two flying leads, of 75mm in length, should then be attached to the centre and left-hand terminals of the switch. Another two flying leads, of similar length, should then be attached to the "tip" and "ring" terminals of SK1.

The p.c.b. is fastened to the rear panel of the case using four insulated spacers. The spacers should be fastened to the inside of the rear panel using countersunk M3 screws. The p.c.b. is then fastened to the spacers using the M3 screws supplied with the spacers.

Once the p.c.b. has been attached to the rear panel of the case then the two halves of the case can be joined together. The aluminium side panel should be placed in the outer slot of the lower edge of the rear panel and the plastic side panel should be placed in the next to outer slot of the upper edge of the rear panel.

The flying leads from the switch and socket should be connected to the p.c.b. terminal block as shown in Fig. 9. The flexible cable from the keypad should now be carefully connected to the header plug on the p.c.b.

The two halves of the case can now be carefully "clipped" together. It is important that no strain be placed on the keypad cable during this operation.

It may be considered expedient by the constructor to consider the advice contained in the following section before applying power to the Darts Scorer. Otherwise the Darts Scorer is now complete and ready for use. Instructions for use are contained at the end of this article.

TESTING

The first test of the assembled p.c.b. should be a visual one, to check for any soldering defects and for the correct orientation of polarised components. If this is satisfactory then an external voltage (9V to 12V d.c.) should be applied to the jack socket, taking care to observe the correct polarity.

Check that +5V d.c. is present at all the relevant points on the p.c.b. If this

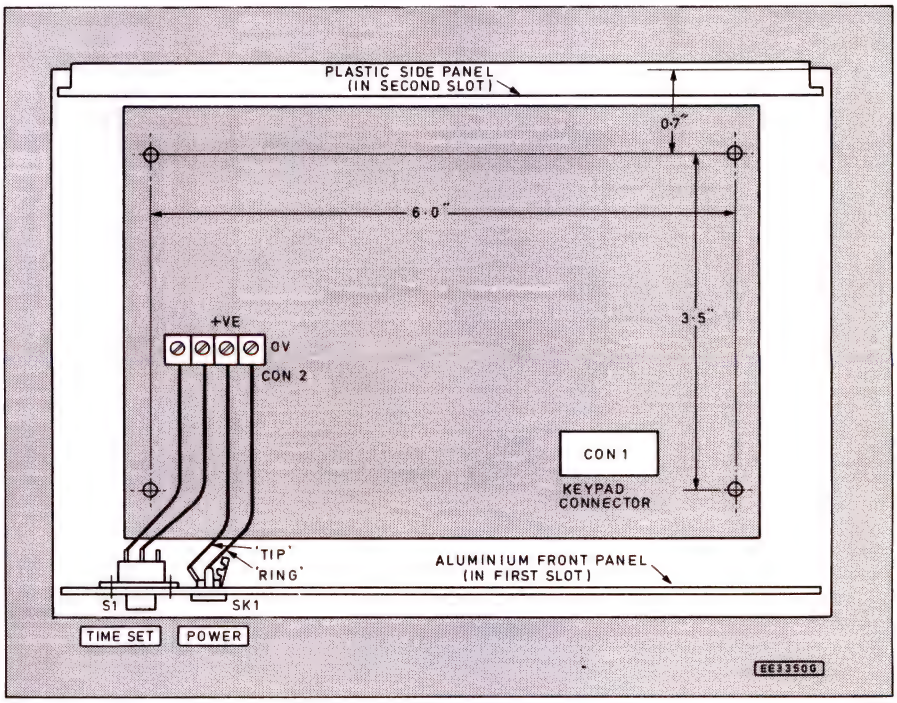


Fig. 9. Mounting the p.c.b. and CON.2 wiring.

voltage is only present at certain parts of the p.c.b. then the p.c.b. should be tested using a continuity checker for dry joints or track breaks. Once the power supply has been verified then the integrated circuits can be inserted into their appropriate sockets. This should be done with power off and care should be taken that the chips are inserted correctly.

Power may then be applied to the p.c.b.. If all is well the displays will show "501" and the left hand l.e.d. will be lit. If this is not the case then the power should be removed immediately and further testing carried out.

Microprocessor based systems are difficult to test without specialised equipment but it is possible, on the Darts Scorer, to test the keypad and display circuitry fairly comprehensively as well as perform simple tests on the microprocessor. It should be noted however that unless incorrect operation is due to faulty soldering or some other easily remedied problem, then replacement of integrated circuits or other components may be necessary.

DISPLAY CIRCUITRY TESTING

The multiplexed l.e.d. display and associated circuitry can be tested statically by following the procedure detailed below. IC6 and IC7 should be inserted into their respective sockets. Each connection shown in Table 1 should then be made to the microprocessor socket, in turn, using temporary "patch" leads and then power applied to the p.c.b.

The voltages, listed in Table 1 simulate the signals the microprocessor produces in order to display an '8' on each digit of the display. Power should only be applied to the p.c.b. long enough to ascertain correct operation of each digit in order to avoid overloading the segment and digit drivers.

MICROPROCESSOR TESTS

The only simple test of correct operation of the microprocessor is to monitor the AS and DS outputs using a logic probe or oscilloscope. The microprocessor should be inserted in its socket and power applied to the p.c.b.. A logic probe should indicate continual pulsing on each of these outputs which will indicate correct operation of the oscillator circuitry. If an oscilloscope is used it will be possible to observe the AS and DS waveforms shown in Fig. 3.

Table 2. Keypad encoder outputs for each key.

Key	IC5 socket pin 14	15	16	17
	D	C	B	A
0	0	0	0	1
1	0	1	0	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	0
5	1	0	0	1
6	1	0	1	0
7	1	1	0	0
8	1	1	0	1
9	1	1	1	0
H/A	1	1	1	1
SUB	1	0	1	1
L/P	0	1	1	1
NEW	0	0	1	1
START	0	0	1	0
TIME	0	0	0	0

"1" = 4.5V min "0" +0.5V max

KEYPAD INTERFACE TESTING

The keypad encoder chip (IC5) can be tested in isolation by temporarily connecting up the keypad to the p.c.b., inserting IC5 in its socket, applying power to the p.c.b. and then pressing each key in turn and monitoring the encoder outputs. Table 2. lists the expected output for each key.

Each time a key is pressed the DA output should also go high, returning low when the key is released. This can be monitored using a logic probe or voltmeter.

DARTS SCORER OPERATION

The Darts Scorer has been designed to be simple in operation. All user input is via the 16 key keypad and user scores (or the current time) are shown on the 6-digit l.e.d. display. The Darts Scorer resets itself on power-up and is ready for immediate use. The Home and Away players scores are set to the default values of 501, keyboard control is with the Home player and the clock is initialised to 00:00.

Whenever the user is required to enter numeric data the software checks, wherever possible, that the input data does not exceed valid limits. For example when entering the current time, in "time set" mode, any digit above two will not be accepted for the first digit of the hours value (as there are only 24 hours in a day).

The 16 keys on the keypad have the following functions assigned to them :–

0-9	Numeric keys. These keys are used for numeric input to the Darts Scorer.
H/A	Home/Away player select. This key is used to select which player has "control" over the keypad. When an operation only affects one players score, the H/A key may need to be pressed first. An l.e.d. illuminates to indicate which player currently has control of the keypad.
SUB	Operation of this key deducts a players most recently entered score from that players current score.
L/P	This key is used to "toggle" the display between displaying the players present scores or the last scores entered. When the last score entered is being displayed, no further keypresses are accepted until the L/P key is pressed again to restore the present scores to the display.
TIME	Operation of this key toggles the display between displaying the present scores or displaying the current time. When the time is being displayed, no further keypresses are accepted until the TIME key is pressed again to restore the present scores to the display (unless the Darts Scorer is in 'time set' mode when the software will allow the entry of the new time).
ENT	This key allows an entered number to be transferred to the players present score. The main purpose of this is to allow different start scores to be entered rather than the default 501. However it can also be used to "correct" the present score if an incorrect score is accidentally subtracted.
NEW	Operation of this key will "reset" the software and allow a new game to be commenced. All relevant variables are initialised and the present score is set to 501 for both players. N.B. the time is unaffected.

ENTERING AND SUBTRACTING A SCORE

In order to enter a score and subtract it from the player's present score, it is necessary to follow the keypad sequence listed below :

(1) H/A (optional)
(2) xxx
(3) SUB

The H/A key may need to be pressed if the keypad control is not with the correct player.

xxx signifies the entered number (of up to three digits). If more than three digits are entered then additional digits will overwrite those already entered.

Table 1. Connections for static testing of displays.

Microprocessor socket pin 14	13	12	11	10	9	8	7	Results
PA0	PA1	PA2	PA3	PA4	PA5	PA6	PA7	
0	0	0	1	0	0	0	1	Home hundreds shows 8
0	0	0	1	1	0	0	1	Home tens shows 8
0	0	0	1	0	1	0	1	Home units shows 8
0	0	0	1	1	1	0	1	Away hundreds shows 8
0	0	0	1	0	0	1	1	Away tens shows 8
0	0	0	1	1	0	1	1	Away units shows 8

"1" = +5V "0" = GND (0V)

Operation of the SUB key will cause the entered score to be subtracted from the present score and also to be stored for possible recall using the L/P key. If the number entered is greater than the present score then operation of the SUB key will have no apparent effect.

If the default start score of 501 is not required then a different start score may be entered by exactly the same procedure as above except that the ENT key should be pressed instead of the SUB key.

The operation of the L/P, NEW and TIME keys are as previously detailed in the keypad functional description.

SETTING THE CLOCK

In order to set a different time for the clock, it is first necessary to place the Darts Scorer in "time set" mode. This is done by first ensuring that the Darts Scorer is displaying the players present score and then moving the Time Set switch to the left hand position. The TIME key should then be pressed. The display will now show four "U" symbols instead of the current time. The new time can now be entered by using the numeric keys.

If an illegal value is entered the Darts Scorer will not proceed to the next digit until a valid digit has been entered. When all four digits have been entered the Time Set switch should be moved back to the right hand position. The TIME key should then be pressed twice to return the Darts Scorer to normal mode.

Good though it is the Darts Scorer will unfortunately not improve your game! ☐

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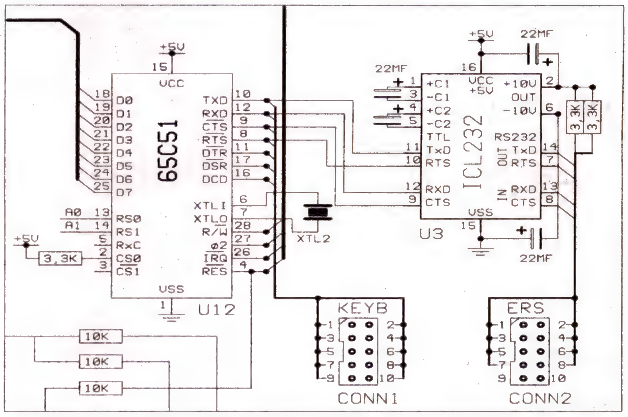

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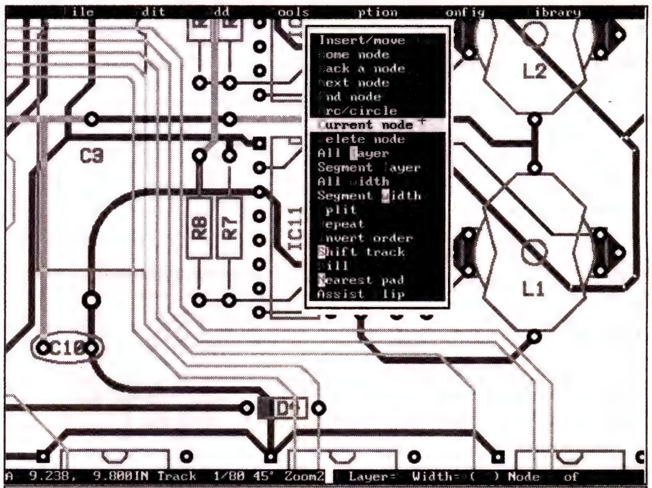

PCB layout editor provides full analogue, digital and surface mount support - ground and power planes (hatched or solid)- 45 degree, arced and any angle tracks.

HIGHLIGHTS

Hardware:

- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
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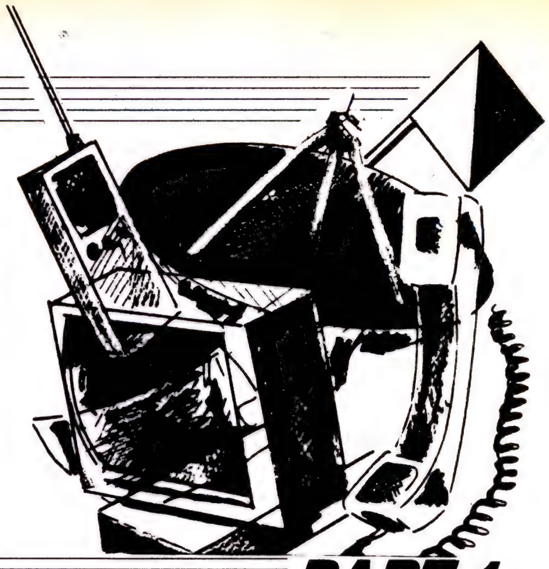
INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 1



THIS is the first article in a twelve part series concerning Information Technology, Communication and other aspects of science. The original intention was to help science teachers deliver Attainment Target 12 (AT12) *The scientific aspects of information technology including microelectronics* in the original Science National Curriculum. However, at the time of writing, there have been some significant changes to this document, some of which are yet to be resolved – more will be said about this later. While preparing this series, it became clear that it would make interesting reading in its own right for anyone interested in electronics whether for National Curriculum purposes or not.

SCIENCE NATIONAL CURRICULUM

Many parents and students have only a vague understanding of the Science National Curriculum so at this point it may be appropriate to give a little background information and to see how the National Curriculum fits into the scheme of science education. Certain simplifications have been made – readers wishing to make a detailed study should obtain a copy of *Science in the National Curriculum* and the later document – *Science for ages 5 to 16 (1991) (Proposals of the Secretary of State for Education and Science and the Secretary of State for Wales)* from HMSO.

The Education Reform Act 1988, provides for a National Curriculum for all children of compulsory school age in maintained schools in England and Wales. In March 1989, the Education (National Curriculum) (Attainment Targets and Programmes of Study in Science) Order 1989 was laid before Parliament. A document entitled *Science in the National Curriculum* was subsequently distributed to schools. This lists specific topic areas called Attainment Targets (AT's) and detailed programmes of study which mast be taught by law. In its original form, there were 17 such AT's which were themselves divided into 10 Attainment Levels and further subdivided into various Statements of Attainment. The lowest levels were appropriate to the youngest children and so on.

Children's education is divided into four "Key Stages". Broadly speaking, Key Stage 1 refers to children from 5 to 7 years, Key Stage 2 children up to 11 years, Key Stage 3 children up to 14 years and Key Stage 4 children up to the school leaving age of 16. The introduction of the Science National Curriculum has been staged as explained in document. If all this seems complicated, there is a further statement of correlation between the age of the child and the expected Attainment Level. Thus, children at Key Stage 1 should cover AT Levels 1 to 3, those at Key Stage 2 Levels 2 to 5, Key Stage 3 Levels 3 to 7 and Key Stage 4 Levels 4 to 10. Note the overlaps built into the system.

At the end of each Key Stage, children are to be tested against the criteria of the Attainment Targets. The tests used are called Standard Assessment Tests (SATs) – sometimes called Standard Assessment *Tasks* by teachers who do not like to regard them as tests. The exact timings of the introduction of SATs and the uses to which they are put is laid out in the appropriate documents.

RECENT PROPOSALS

On 8th May, 1991 the Secretary of State for Education published proposals for simplifying the original scheme. Thus, the 17 original Attainment Targets are to be replaced by five new ones. There were several reasons for doing this which need not be discussed here. However, he made it clear that the entire programme of study would not be significantly changed – only the simplified structure of the Attainment Targets and Statements of Attainment therein. Thus, teachers' plans for courses would remain valid but the demands of assessment, hopefully, reduced.

Existing Attainment Targets have therefore been amalgamated under broader descriptions and there remain ten Attainment Levels in each as before. However, rather than the 409 Statements of Attainment in the original scheme there are now only 178. The Programmes of Study have also been altered to reflect these changes.

It is said that this will assist examining bodies to support the National Curriculum and should also help parents understand reports on pupils' progress. It turns out that the present work no longer appears in one attainment target – AT12 – but now appears in more than one and in the detailed Programmes of Study.

It is expected that assessment in Key Stage 1 in 1992 will use the existing Attainment Targets. However, the first statutory Key Stage 3 assessment will be made in 1993 using the new AT's. It is hoped that GCSE examinations will reflect the new structure in 1994.

Since this series was already well advanced at the time of announcement of the new proposals and because the original material is still valid, it will follow the structure of the original AT's. It is thought that, for the purpose, this forms a more convenient pattern anyway. However, to avoid ambiguity between old and new schemes, references to specific Attainment Targets and associated Levels of Attainment have been removed.

A TEACHER'S LOT

Aspects of information technology and electronics are among the least popular subjects to teach in the National Curriculum. This is because teachers with little or no specialist background are being asked to teach topics for which they feel ill-prepared. Much of this feeling is unfounded and comes down to terminology.

Scientists have long promoted a "closed shop" attitude. By using certain words and phrases – by using special terminology and jargon – they have succeeded in keeping non-specialists at bay. By avoiding some of this jargon and presenting this series in everyday terms, teachers, parents and students alike will see that these topics are fairly straightforward to teach and enjoyable to learn.

The content of the earlier parts will be of particular interest to those teaching young children. However, although the content has been kept fairly simple, childish language has been avoided – it is up to the reader to interpret the style and level of the information appropriate to the ages and abilities of the children concerned.

PRACTICAL WORK

This series aims to help teachers, parents and students by exploring topics in and around the National Curriculum. Practical work is suggested which will reinforce and add interest to certain topics. It must be stressed that there is far more material here than will be needed to study a particular topic. Likewise, some topics have not been covered at all and standard text-books will be needed for these.

This series is designed as a resource from which ideas can be drawn as required. Some of the work is of a more advanced nature than will normally be required – this may be useful for more able children. The path chosen will depend to a large extent on the interests of the teacher, of the children and the facilities available.

The National Curriculum is fairly vague in its statements of attainment, this vagueness in practice allows quite a lot of freedom in its delivery. However, users will need to keep an eye on the Programme of Study.

Where practical work is suggested, this will use simple equipment. For later levels, some specialized components will be needed but every effort has been made to keep costs to a minimum by using home-made parts wherever possible.

Parents may wish to pursue this series with their children and, in so doing, complement the activities of the hard-worked teachers at their local school. Although teachers are charged with the actual delivery, recording and documentation for the National Curriculum, some parents with a few hours to spare per week may wish to attend clubs and workshops at the school and so back-up the National Curriculum in a relaxed atmosphere. Most of the practical work would be appropriate here.

OFF WE GO!

This section is to show young children that certain everyday devices will receive text, sound and images over long distances, using information technology.

The modern world abounds with such devices. Everyone is familiar with radio (sound) and television (images). An increasing number of television receivers have a teletext facility (text) so that they can receive pages of written information, magazine style.

Television and radio normally *receive* information but the telephone can *send* it too. The telephone allows you to speak and listen (that is, transfer information) with just about anyone in the world. Telex (text) and Fax (images) are a further two information facilities now fairly commonplace.

Young children should know a little about some of these. They will not understand some of the words but these may be simply accepted for the moment. They should be aware that all these devices handle *information* – whether this be the spoken word, music, pictures or text. They should know that these modern devices provide us with information more quickly or more conveniently than "old" methods and that this, hopefully, helps us to become more informed members of society. Modern handling of information is called *information technology*.

Children should know that it is not the actual sound, pictures, text, etc. itself which travels from one place to another but that the information is first converted into *electrical signals*. These can then travel over vast distances quickly and conveniently either through wires or by means of *invisible waves* (radio waves).

Children often believe that telephone wires carry the sound itself and saying things like "we speak in here and the sound comes out there" seems to imply that it is the same sound going in which finally emerges at the other end. This could cause problems later. For many children the foregoing will be more than sufficient. However, here is some basic information which may be drawn upon as required.

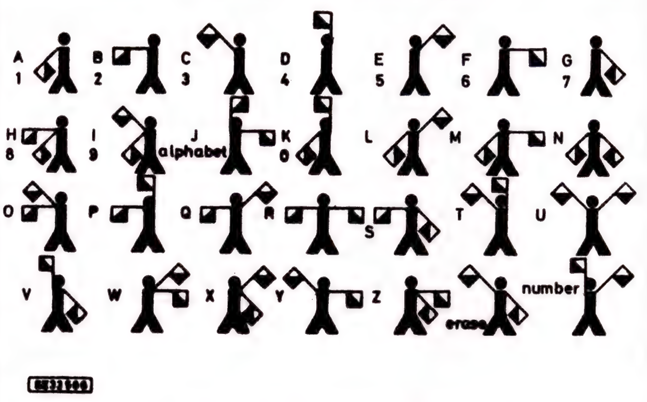


Fig. 1. Flag signals used in semaphore.

RADIO

At a distant studio, people talk, sing or play music. This may be "live" or "recorded". The sound is picked up by a *microphone* and turned into *electrical signals* which are then sent along a wire. These signals are an *electrical copy* of the sound – all the information about the sound is contained in them. This wire carrying the electrical signals is connected to a *transmitter* which makes radio waves.

The electrical signal is mixed with the radio waves and transmitted from an *aerial*. The radio waves carrying all the sound information spread out through space. A distant radio receiver picks up the waves using an aerial of its own (which is often inside the radio or may be a telescopic rod on top). An aerial just collects the waves which happen to reach it – some children believe that they are attracted to it. A circuit inside the radio removes the sound information from the radio waves and reproduces it by means of a *loudspeaker*.

The back of an old transistor radio may be removed and the following parts identified – aerial, electronic circuit, loudspeaker and the battery which provides the power. It could be mounted on cardboard and these parts labelled. It would be a good idea to compare a modern transistor radio with an old-fashioned valve radio which is much larger – someone is sure to have one of these in the attic.

With the back removed from an old but working transistor radio – **this must be battery-powered and not mains-operated** – it may be possible to touch the cone of the loudspeaker. With music playing, the vibrations may be clearly felt.

Radio waves can travel much greater distances than sound itself so we can hear people talking or music playing even though the studio is a long way from the listener. Radio waves have different *frequencies* and the transmitter will send the information using just one particular frequency. The radio is *tuned* to the frequency we want – this is shown as a number on the dial.

In this way we only hear the broadcast we want and not those using the other frequencies which the aerial receives. Compare this with a lot of people all talking at once – it is difficult picking out the voice you want to hear. This is another advantage of using radio waves rather than sound itself.

Perhaps a pair of walkie-talkies could be used to illustrate the principle of two-way radio communication where information can be sent as well as received. Children will not understand the concept of radio waves but may understand that they are like light (which is very real) but invisible and able to go round corners, bounce off things (reflect), etc. They may be told that microwave ovens use radio waves to cook food instead of for communication. They may also understand radio waves being used for radar where a picture of a distant ship, aircraft, etc. is produced by reflecting the waves off them.

Terms like "on the air" should be avoided. These are confusing because they imply that radio waves need air to travel through. This was once thought to be the case but is not so. If it were true, we would not be able to receive information from distant space craft or from satellites. Radio waves travel and carry information with the speed of light – the equivalent of seven circuits of the earth per second. "300,000km per second" means little to children.

TELEVISION

Television uses radio waves too. However, this time *pictures, sound* and *text* are turned into electrical signals then sent by wires to the transmitter. They are then carried by the radio waves from the transmitter aerial just like a radio broadcast. If a teletext receiver is available, this should be shown and children familiarize themselves with the index page. They should be encouraged to choose the information they want rather than just pressing buttons at random.

They should understand that not everyone needs access to all the information so only the page required is called up as needed, for example, a weather map. They should understand that the pages are being

A ·–	J ·–––	S ···	2 ··–––
B –···	K –·–	T –	3 ···––
C –·–·	L ·–··	U ··–	4 ····–
D –··	M ––	V ···–	5 ·····
E ·	N –·	W ·––	6 –····
F ··–·	O –––	X –··–	7 ––···
G ––·	P ·––·	Y –·––	8 –––··
H ····	Q ––·–	Z ––··	9 ––––·
I ··	R ·–·	1 ·––––	10 ––––––

Fig. 2. The Morse Code.

sent one after another continuously like flicking through the pages of a magazine. To find the one they select may therefore take a little time. Note that teletext is called Ceefax on BBC and Oracle on ITV.

THE TELEPHONE

Pressing the correct buttons (or using the old-fashioned dial) sends *electrical signals* along the *telephone line* to the *exchange.* This connects your telephone to the one you wish to speak to. A *microphone* at one end converts speech into electrical signals which then travel along a wire (optical fibres are mentioned later in the series!). These signals end up at the distant telephone and an *earpiece* converts them back into sound.

By having a microphone and an earpiece at each end, true two-way conversation is possible. This should be compared with radio and television – in the telephone the signals are carried along a wire so the conversation is kept "private". Signals carried by radio waves can be picked up by anyone with a suitable receiver. Some child will probably mention a cordless telephone which may be described as a mixture of radio and telephone techniques. Similarly, there may be some children who mention car telephones. A simple home-made electrical telephone will be described next month.

If Fax is available – and many schools are now suitably equipped, this could be demonstrated. This shows that not only can speech information be sent along a telephone line but *text* and *pictures* can also be turned into electrical signals and this information sent along too.

Allow the children to send a home-made greeting poster to children at a distant Fax machine. They can then receive a greeting back. The children may compare this technique with the postal service where the actual poster would be sent. Comparisons with regard to speed, cost, convenience, quality, etc. would make a useful exercise.

Young people accept all these long-distance communications devices and treat them as if they had always existed. It is therefore useful to look at some early methods of communication to build up a perspective. This also lends itself to some inexpensive practical work which can be great fun.

LONG DISTANCE COMMUNICATION

For long distance communication we show children in greater detail that there is a wide variety of means of communicating information over long distances. In a later article we show how information can be *stored* using a variety of devices including the computer.

We shall explore some of these methods of long-range communication – past and present. We shall also look at some of their history. After that, we shall discuss some simple experiments which can be done to illustrate some of them.

Since the very earliest times, people have felt the need to communicate with one another. Over short distances this is fairly easy – crude drawings and grunts can convey simple ideas fairly well. However, speech developed and a more sophisticated transfer of ideas became possible. Man could now discuss complicated issues and express feelings which had hitherto been impossible. Unfortunately, communication by speech was successful only over short distances. Shouting at the top of ones voice could increase the range but only by a relatively small degree.

In ancient times, messages were sometimes sent over long distances by using a chain of people shouting from hill top to hill top. It is easy to see that the message could become distorted and end up quite different from the original one! This could be tried out by the children on a small scale.

BEACONS

Beacons (bonfires) could be used for long-distance communication but, of course, lighting a beacon had to have just one unambiguous meaning. By arranging for a string of beacons to be set up on hill tops so that the previous one was visible to an observer at the next, the message could be sent quickly by lighting the beacons in turn. In this way, a simple message could reach all parts of the country in a very short time.

In 1588, Britain was under threat of invasion by the Spanish Armada. A set of hilltop beacons was set up to pass on the warning quickly if this were to happen. The disadvantage of the simple beacon is that the message is not easily changed. Long before, the ancient Greeks had developed a system of torches placed on hill tops. By using certain patterns of torches to represent the letters of the alphabet, messages could be spelled out – a sophisticated method for its day.

In Africa, fairly complicated messages are sent over relatively long distances by means of drums. A similar idea is to use smoke signals. This method was once used by the Red Indians and other peoples.

Some people developed ways of increasing the range of the human voice – "whistling languages" and yodelling by mountain dwellers are examples. The written word could be carried by a runner or runners (relay fashion) or carried on horseback to a distant person. This method was relatively slow. The first marathon was run in Greece in the battle of Marathon (490 BC). A Greek runner named Phidippides ran from Athens to Sparta to summon help. However, the Greeks had defeated the Persians before the help arrived.

The natural homing instinct of a pigeon could be exploited by attaching a small written message – this method was successfully used in wartime to send messages across enemy lines until fairly recently. The advantage here was that the message was quite secure since a pigeon flying by did not attract much attention.

Optical Telegraph

No major developments took place from these early times until the late 18th century when a French engineer, Claude Chappe, demonstrated his invention – the "optical telegraph" – in 1793. This consisted of long arms on tall poles. The arms could be pivoted in certain ways with each pattern representing a letter of the alphabet, a number, etc.

The posts were placed about six miles apart with an operator at each one looking through a telescope at the one before. It is said that a message from Paris to Lille – a distance of over 200km, arrived within two minutes. Chappe's telegraph was widely used, especially to convey military information. By 1796, Britain had a Chappe telegraph system operating between London and the channel ports. Signalling with two flags (semaphore) is a small-scale variation of the Chappe telegraph. This uses the idea that each letter of the alphabet may be represented by holding the flags like the hands of clock (see Fig. 1).

Morse Code and Flags

Long-distance communication could be achieved by flashing the sun's light using a mirror (the heliograph) or by flashing a lamp (the Aldis lamp). Here the Morse Code (see Fig. 2) could be used. This is a

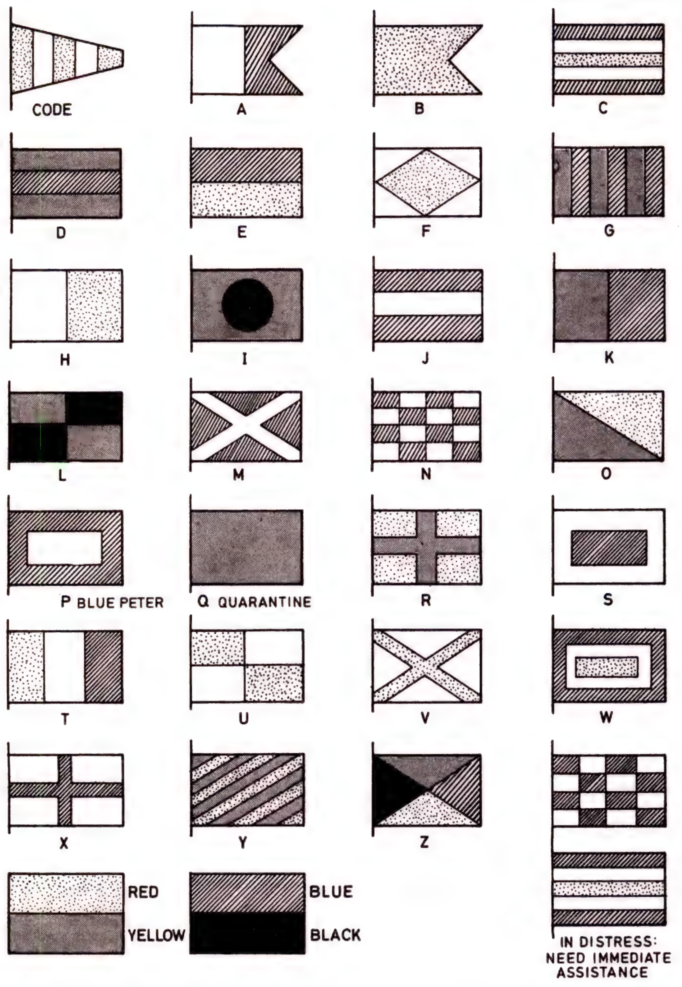


Fig. 3. Brown's International Code of Flag Signals.

system of "dots" and "dashes" used to represent the letters of the alphabet, numbers, etc.

Brown's International Code of Flag Signals (see Fig. 3) used on ships is interesting. Here, flags are hoisted for the distant ship to observe by means of a telescope. The flags may be used in two ways. The pattern and colour of each flag represents a particular letter of the alphabet and the words may be spelled out. Alternatively, the same flags have meanings in their own right so for day-to-day messages a few flags can communicate quite complicated ideas even between people speaking different languages.

For example, the flag representing the letter C also means "yes". The flag representing the letter I also means "I am altering course". Just about everyone knows what a white flag or a flag bearing the Skull and Crossbones means! (although these two are not part of the International Code).

In the modern navy, there are times when radio silence needs to be observed (since the radio signal can be picked up by the enemy). Here, the International Flag Code, semaphore signals and the Aldis lamp come in useful.

Communication between continents remained a problem until recent times. The only method available in early times was to carry a letter by ship. In the early 19th century a letter to America would take several days to arrive and, of course, a similar time for the replay to be received by the original sender. It seems difficult to believe that this was the only method possible until the electric telegraph was invented. This will be looked at in more detail next month.

EXPERIMENTS: SPEECH COMMUNICATION

Use some of the following ideas to extend the range of your voice:

1. String telephone: This experiment needs two people, two yogurt containers and a long piece of thin string. The string is passed through a hole in the bottom of each container. Knots are then tied to prevent the string from pulling free (see Fig. 4). Two children go to a large open space and take one container each. The string is now pulled fairly tightly. One person speaks closely into one yogurt container while the other listens at the other.

Encourage speaking in whispers. Let them try communicating in both directions. Ask them how one person can signal the other that he or she wants to speak. See if they can devise a string telephone to provide true two-way communication. They can investigate the range of the device and see if the type of string makes any difference. Let them try to communicate round a corner and comment on the result.

This makes a very instructive and enjoyable lesson. The children should be shown that sound is caused by vibration – "twanging" a ruler will illustrate this or a variety of musical instruments could be used. The vibration of cymbals or a drumskin may be clearly felt.

In the string telephone, each yogurt container bottom acts as a diaphragm. The first one vibrates due to the sound of the voice and the string carries these vibrations to the second diaphragm. The string prevents the vibrations from spreading out so that the voice can be heard at a greater distance than would be possible without it.

2. Speaking tubes: It is possible to speak over a fairly large distance using a hosepipe or some rubber tubing. Fit a funnel to each end and let the children use these to speak and listen in turn. Investigate the range by using as long a piece of tubing as possible. Let them find

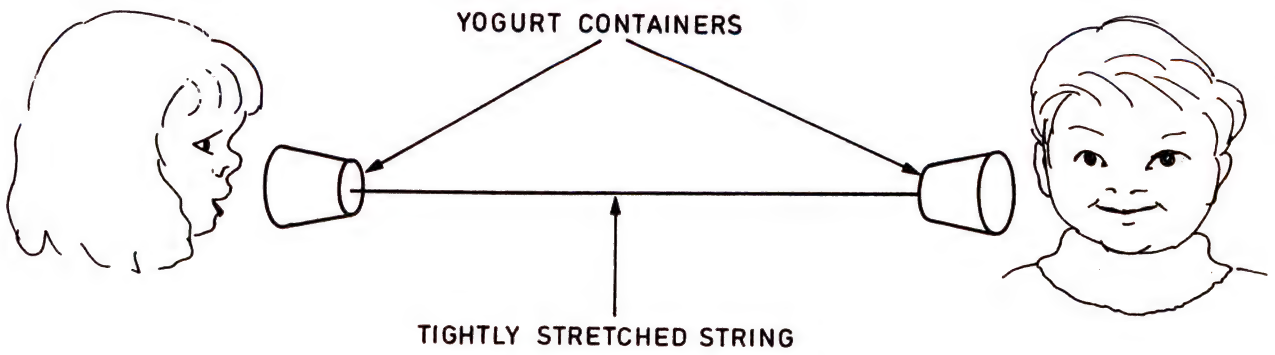


Fig. 4. Principle of the "string telephone."

out what happens when the tubing is squashed. Discuss the advantages of using such a method on board ship.

The same idea was once used in large hotels. For this, there was a whistle at each end. The "caller" removed his or her whistle and blew hard. The whistle at the distant end would then sound. The person being called would now remove his or her whistle and establish a conversation. Like the string telephone, the vibrations themselves are carried along the tube – in this case by the air inside. The tubing prevents the vibrations from spreading out as they would in free air and so extends the range.

3. Whistling language. The children may invent a whistling language. Whistles may be short or long, high and low notes, etc. They may then go outdoors and try it out. They can test the range and efficiency of such a language. Someone may even try yodelling! The children may give their ideas as to why this method extends the range of the voice.

Note that in all these experiments, it is the actual sound which is carried unlike the radio and television signals. If you had a piece of rubber tubing long enough to reach Australia and spoke into one end, the sound would be far too quiet to be heard by the time it reached its destination. Also, it would travel at the speed of sound which is much less than that of radio waves. This would mean that it would take about 16 hours to reach Australia!

NON SPEECH COMMUNICATION

Use some of the following to communicate at a distance without using the human voice:

1. The Heliograph: Use a mirror to flash sunlight to a distant person. A home-made code of flashes may be used to mean everyday things. Alternatively, the Morse Code could be used to spell out the message. If the day is not sunny, flash a torch instead (Aldis lamp).

2. Semaphore: Let the children make two flags and use them to send messages. They may then check the speed and range at which messages may be sent and received.

3. The International Code of Flag Signals: Use the International Signal Code (Fig. 3) to draw and colour some flags which are then used to send a message. This is a good and relatively quiet indoor activity. Someone is certain to be amused by the Blue Peter (which is hoisted on a ship about to leave port). Find out the meaning of "flagship".

Next time we shall look at some experiments using simple electrical apparatus to illustrate long range communication.

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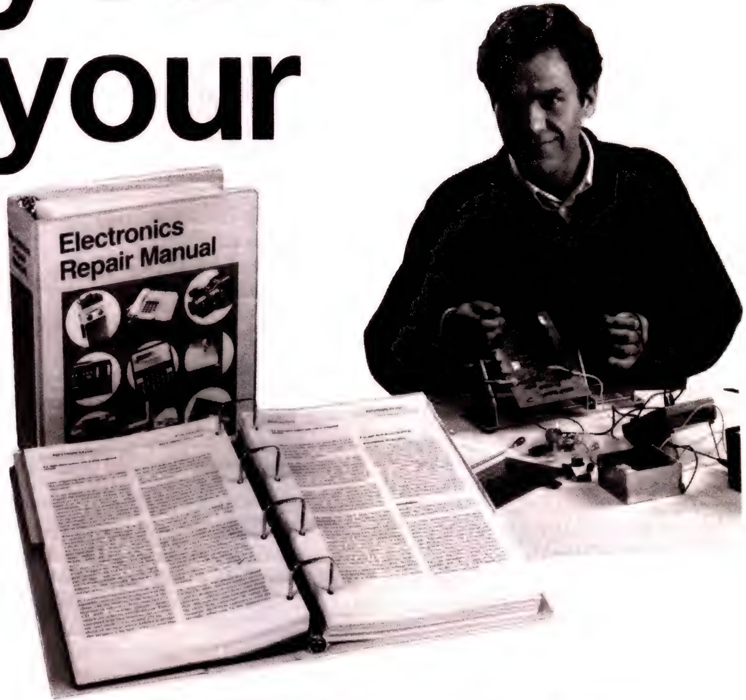

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REPORTING AMATEUR RADIO

Tony Smith G4FAI

NO GEOSYNCHRONOUS SATELLITE

1991 marks the 30th anniversary of the launching of the first amateur satellite, *OSCAR 1*. In the intervening years the amateur space programme has been divided into phases intended to lead to phase IV, the launching of geosynchronous satellites providing 24 hours continuous coverage from "fixed" positions around the world.

According to a recent report in *The AMSAT Journal*, the Board of Directors of AMSAT, the Radio Amateur Satellite Corporation, have decided to terminate the phase IV programme because of the huge, multi-million dollar, costs involved compared to previous projects costing tens of thousands of dollars.

A new project is now under consideration, known as phase III D, which will be a super enhanced amateur satellite in a high elliptical orbit, with improved performance and facilities compared to present phase III satellites. While the cost of a geosynchronous satellite would have had to be met only by groups served by the satellite the new project, having world-wide communications capability, can be financed with assistance from users on a world-wide basis.

A FEW STATISTICS

Figures published recently show that there are now 1,074,367 licensed amateurs in Japan. This represents a gain in one year of over 47,000 new licenses, nearly as many as the entire total of amateur licences in the UK! Twenty one years previously there were just 100,000 amateurs in Japan.

At the end of December 1990, there were 19,194 Australian amateur radio licences. By comparison, CB licences totalled 407,844. During the preceding quarter, amateurs increased by 156 and CBers by 11,848. *Amateur Radio*, journal of the Wireless Institute of Australia, raises the question, "When there is that much interest in radio as a communication method, why is the amateur service attracting so few newcomers?"

In June 1991 the official number of amateur licences in the USA was 523,351. This appears to be a 15.2 per cent increase over the previous year's figure, but as from the implementation of a 10-year licence in 1984 those dropping out from amateur radio are remaining on the official data base until the first ten years have expired. As a result, until recently, these official figures really indicated a continuing reduction in the number of licensed amateurs in the USA. Since March 1991, however, a new VHF licence not requiring a Morse code test has resulted in an upsurge of new licences (10,000 in the first 60 days) and the statistics are now being viewed more optimistically. *(W5YI Report).*

NEW BOOK

From the pen of Ian Poole, G3YWX, comes yet another publication aimed at the beginner to amateur radio. *Setting Up An Amateur Radio Station* provides the sort of practical advice and information I would have greatly welcomed when I set up my first station.

Much of the advice is applicable to either a short wave listening or transmitting station, and for SWL's there is brief information on the different types of amateur radio licence available, including the new novice licence, and how to obtain them. Of necessity, some previous knowledge is assumed and an SWL not already familiar with basic radio theory might find some parts of the book hard going.

While it is *not* a highly technical book it would certainly be of most value to someone who has just passed one of the amateur exams or, at the very least, has read the author's previously published *An Introduction to Amateur Radio*. A chapter on "Receivers and Transmitters" offers advice on buying new or second-hand equipment, the facilities to look for, frequencies to be covered, sensitivity and selectivity, desirable modes and so on.

Having acquired the equipment it needs to be suitably located, as is explained in a chapter "Setting up the Shack". Some operators make do with an odd corner of the house, perhaps a cupboard. Some have a whole room set aside for the purpose, while others use the loft, a part of the garage, or a specially adapted garden shed.

SAFETY IMPORTANT

The layout of the equipment should be planned for ease and comfort of operation compatible with electrical safety. The wiring of the shack is important in this context and the use of a Residual Current Circuit Breaker (RCCB) is strongly recommended, together with a single switch to cut off power to the whole station when not in use. A good earthing arrangement is also of great importance to overcome problems associated with r.f. instability when transmitting.

The performance of the aerial serving any station, transmitting or receiving, is crucial to successful operation. A chapter on this subject suggests that time and money invested in the aerial is likely to be far more worthwhile than replacing the equipment in the shack with the very latest model.

For any location there will be a variety of aerials which can be used. The advantages and disadvantages of different types are discussed together with the different types of feeder arrangement, plus aerial tuning units which provide a good "match" between the equipment and the aerial in some circumstances.

TEST EQUIPMENT

A useful chapter on "Test Equipment and Testing" explains the use of the multimeter, including metering in circuit, diode tests and transistor tests. The function of the grid-dip oscillator (also known as a gate-dip oscillator, f.e.t. dip oscillator or by other nomenclature) is explained, including measuring the resonant frequency of a tuned circuit, measuring inductance and capacitance, the resonant frequency of an aerial, the electrical length of a feeder and feeder impedance.

Brief notes also introduce frequency counters and oscilloscopes. In both cases more information would be needed before thinking seriously about acquiring such equipment but this is inevitable in a publication of this size (86 pages).

There is enough basic information in this book to help a newcomer set up a simple but effective amateur radio station and the author has succeeded in his declared aim of helping the newcomer learn from the mistakes of others "without having to find out the hard way too much." There are useful "further reading" lists at the end of each chapter to help those wishing to go deeper into any particular matter.

Setting Up An Amateur Radio Station, by I. D. Poole, is published by Bernard Babani (publishing) Ltd, price £3.95. *(Available from the EE Direct Book Service – see this issue for details.)*

MEMORY PROMPTED

Its funny how some of the things I write about prompt half-forgotten memories. Last month I briefly mentioned my RAF service and this has reminded me of my very first meeting with a radio amateur.

I was on guard duty at RAF Butterworth in north Malaya (as it was then), patrolling the jungle perimeter of the airfield accompanied by a soldier from the Malay Regiment. One of our checkpoints was the RAF transmitting station located at a remote part of the site. I walked in on one occasion, in the early hours, to find the operator using the RAF's powerful international transmitter as an amateur station, chatting happily with a young lady in Texas.

It made quite an impression on me, although I don't know what my Malayan colleague thought of it all. At that time such activities seemed far beyond my reach so the incident, although interesting, faded in my memory.

The operation was of course quite illegal and could have resulted in severe disciplinary action if discovered by the authorities. It was a long time ago, however, and I'm sure they don't do things like that in the RAF nowadays!

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LIGHTING

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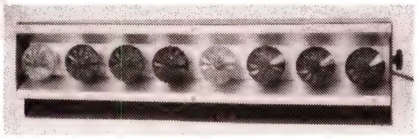
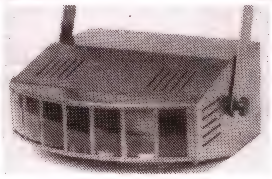


Self contained 8 light sequencer in a metal case. Built in sound detection circuit allows the speed of the sequence to react to the beat of the music. Lamps with red, green, blue and amber covers. Wall/ceiling mounted. 240V.

Sundancer £315.00



Sundancer in metal case for wall/ceiling mounting. Produces 7 flat beams of different coloured light which rotate to the beat of the music. Fan cooled, fused and with a thermal cut out. 240V. Bulb 500W.

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Moonflower in a grey metal case with ceiling mounting bracket. Fan cooled with 150mm lens, built in sound to light controller to give multi-coloured beams of light to the music. Bulb 250W. Power 240V.

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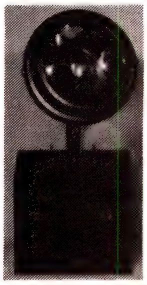

Par 36 single headed scanner in grey metal case. 220° rotation forward and reverse. Complete with transformer and PAR 36 bulb. 240V.

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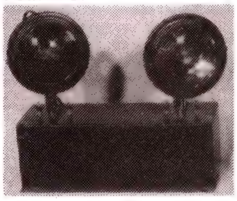
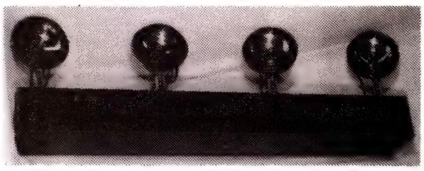


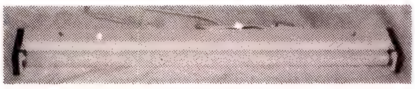
PAR 36 double headed scanner in grey metal case. 220° rotation forward and reverse on separate motors. Complete with transformer and PAR 36 bulbs. 240V.

SCA4 Scanner £159.00



PAR 36 four headed scanner in grey metal case. 220° rotation forward and reverse on separate motors. Complete with transformers and bulbs. 240V.

FF1 Fluorescent Fitting £4.99



2', 600mm British made fluorescent fitting complete with 18 watt slimline tube. Wall, ceiling or cabinet fixing.

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3', 900mm British made fluorescent fitting complete with 30 watt slimline tube. Wall, ceiling or cabinet fixing.

RO80 Coloured Bulbs £5.90

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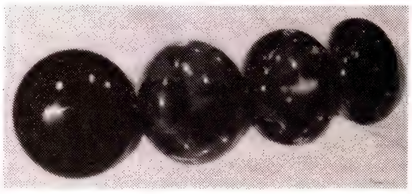

RO80 E.S. 60 watt bulbs in four colours; red, blue, green and amber. Supplied in packs of four.

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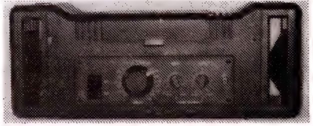

Portable Amplifier with 25W per side output from built in amp and speakers. Complete with microphone socket. For use with your 'Walkman' or any source with small headphone jack. Can be powered by battery or a 12V adaptor, not included.

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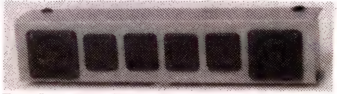

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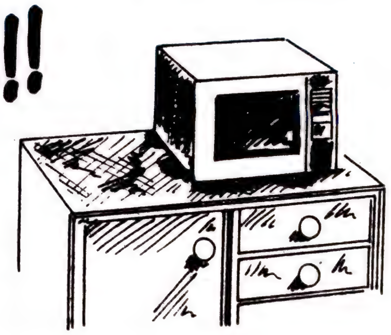
MINI-MICROWAVE



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PROJECT 5

A novel series which combines two hobbies in one – electronics and model-making. Simple electronic circuits combined with easy-to-assemble models that cover a wide range of interests.

A COUPLE of months ago we presented an essential adjunct to the twentieth-century doll's house, a micro-microcomputer. Now we cater for the gastronomic inhabitants of the doll's house with this design for a mini-microwave oven. This is built to the standard one-twelfth scale, originally one inch to one foot, and comes complete with a kitchen unit to stand it on.

The kitchen unit has the more essential function of concealing the electronic circuit which drives the microwave. If you already have a kitchen unit or similar piece of furniture in which to hide the circuit board, you do not need to build our unit.

The action of the oven simulates that of a real microwave oven, the main omission being that it does not generate microwaves and so does not cook anything. When the oven is in its stand-by mode a green l.e.d. glows on the control panel, representing the usual digital clock. The interior oven lamp comes on when you open the door to put the food on the turntable, and is extinguished when you close the door again.

When you touch the contacts on the control panel, the interior lamp of the oven comes on once more until the food is "cooked". At the same time, the green l.e.d. flashes on an off once a second, simulating the timer display counting down the seconds. This takes about 30 seconds at the end of which time the interior lamp goes out, the l.e.d. returns to glowing continuously and four to six high-pitched "beeps" indicate that the food is "done to a turn".

ASSEMBLING THE KITCHEN UNIT

The kitchen unit is made from sheet polystyrene, available from modeller's shops; we used sheets in two thicknesses, which we refer to as thick (2.5mm) and thin (0.5mm). The joints are strengthened by gluing lengths of angle-plastic (2.5mm x 2.5mm) into them.

The unit is a simple shell, without back or bottom. Rectangular panels stuck on the front are painted a contrasting colour to give the appearance of a cupboard and four drawers, but these do not actually open.

The assembled unit is shown in Fig. 1. Begin by drilling the hole in the top. This is for the wiring, assuming the oven is to stand on the right. Drill it further to the left, if preferred. Next glue the sides to the top; the front edge of the top projects 1mm. Without waiting for the glue to set, glue the front panel in position, with a piece of angle between it and the top. Also glue the back bar across from one side to the other, with its lower edge level with the lower edges of the sides. Form the toe-space from the two strips strengthened with the two remaining angles, as in Fig 2. Put the unit aside for at least six hours for the cement to harden.

COLOURS

We painted the unit in two contrasting colours. If you prefer a single colour, glue the door and drawers on the front and

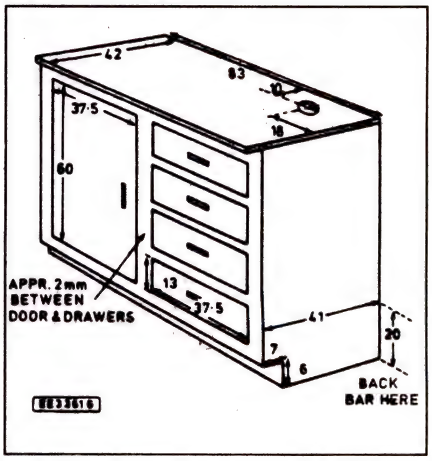


Fig. 1. Construction of the kitchen unit.

CUTTING LIST

UNIT

Thick plastic	
Top	83 x 42
Sides	75 x 41 (2 off, with toe-space cut out)
Thin plastic	
Front	83 x 69
Toe-space	83 x 7
	83 x 6
Back bar	83 x 20
Door	60 x 37.5
Drawers	12 x 37.5 (4 off)
Angle plastic	
	77 long (3 off)

(all dimensions in millimetres)

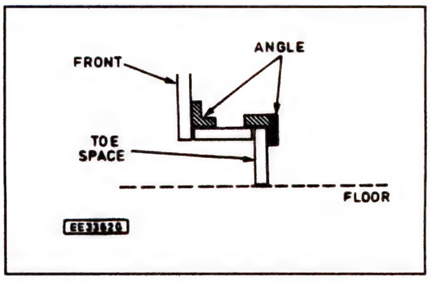


Fig. 2. Construction of the toe space using angle plastic.

paint the whole unit. For a two-tone unit, mark in pencil the positions of the door and drawers on the front of the unit. Paint the unit in the basic colour, leaving the door and drawer areas mainly free of paint; just carry the paint a little over the drawn lines so that there will be no gaps in the painting.

Leave the top if it is to be in the contrasting colour, but paint its edges in the basic colour. Paint the door and drawer panels in the contrasting colour. When the paint is dry, glue the panels in place. Then paint the top in the contrasting colour, if not already painted.

Make the door and drawer handles from scraps of plastic or other suitable oddments and glue these in position.

ASSEMBLING THE OVEN

The oven is 30mm deep with a 3mm thick door hinged to it on the left, and a 3mm thick control panel fixed to it on the right (Fig 3). The cutting list for the oven is shown below. Due to the size and arrangement of the door operation this model is not suitable for card construction. The card available with the kits (see Shop Talk or the Special Offer page) is for the circuit card and oven liner only.

The cut-out in the oven front panel for the microswitch may need to be a different size or shape, depending on the dimensions of the microswitch lever.

Drill the hole in the bottom of the oven, then glue the sides to the top and bottom. Attach the front panel, with two pieces of angle at the front corners. Push the narrow end of one of the hinge brackets out through the slit in the front panel, gluing the wider part to the underside of the oven top (Fig. 4). Glue the other hinge bracket vertically beneath it, to the underside of the oven bottom.

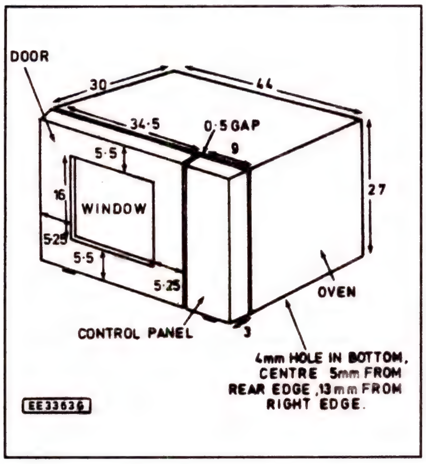


Fig. 3. Construction of the Mini-Microwave.

The rear panel has two strips of angle glued to it (Fig. 5). They should be just long enough to hold the panel firmly in the back of the body when pushed in.

OVEN DOOR

Cut out the door; the window aperture can be made by marking a rectangle for the aperture, then drilling a row of 1mm holes just inside the rectangle. Cut between the holes with a sharp craft knife. File the edges of the aperture to make them smooth. Cut the slot at the top left of the door so that the projecting end of the upper hinge lies neatly within this when the door is in position. Drill holes at the top and bottom of the edge of the door. The drill bit may soon become warm and, if drilling is prolonged, the plastic will melt and a hole of larger diameter may be produced. To avoid this, drill for no more than a few seconds at a time, removing melted plastic from the drill bit between each drilling.

The door facing is made from thin plastic sheet with the same outer and aperture dimensions as the door but lacks the hinge slot and drilled holes. Cut a rectangle of transparent plastic film (acetate sheet) about 28 x 20. Taking care to avoid excess glue, glue the door facing to the front of the door, sandwiching the transparent film between them. It is best to leave hinging the door until all other work on the oven has been done.

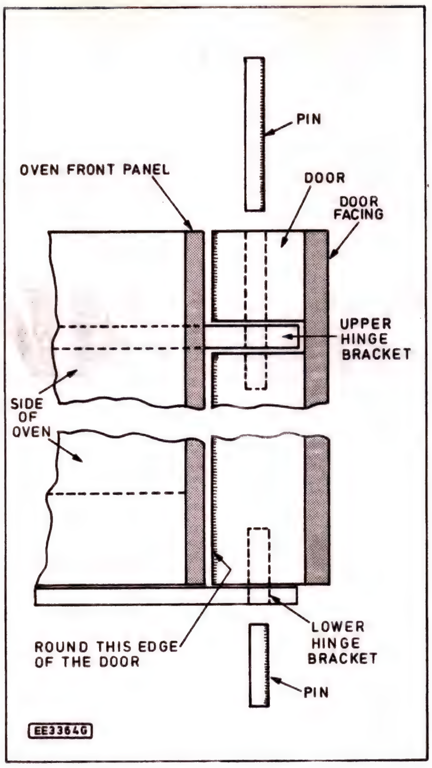


Fig. 4. Arrangement of the door hinges.

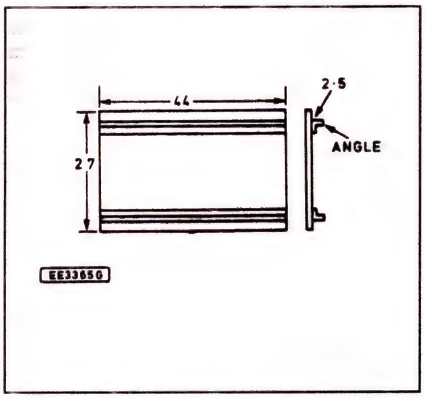


Fig. 5. Oven back panel.

CUTTING LIST

OVEN

Thick plastic	
Top and bottom	44 x 30 (2 off)
Door	34.5 x 27 (see diagram)
Control panel	9 x 27 (see diagram)
Thin plastic	
Sides	30 x 27 (2 off)
Front panel	44 x 27 (see diagram)
Rear panel	44 x 27
Door panel	44 x 27
Door facing	34.5 x 27 (with window, see diagram)
Control panel facing	9 x 27 (see diagram)
Hinge brackets	15 x 5 (see diagram)
Angle plastic	
Vertical corners	21 long (4 off)
Rear panel	44 long (2 off)

At this stage, paint the oven; the door and control panel are usually in a contrasting colour, black in many makes of oven.

LINING

Cut the oven lining from thin card, the same colour as the oven. Bend it and glue it to form an open-fronted box. Bend the four lugs on the front edges of the box outward, ready for sticking to the rear of the oven front panel.

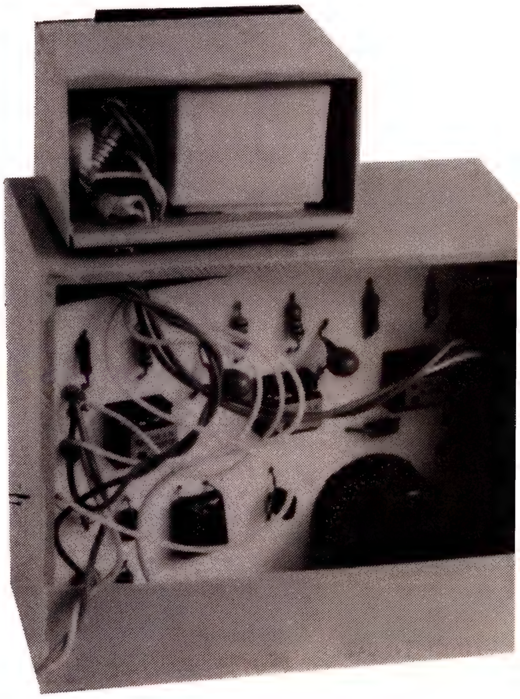
There is a small window on its right side for the interior lamp; glue a piece of transparent acetate sheet over this. For greater realism, apply a rectangle of Letratone to this, to make it look as if the window is covered by a perforated metal screen. We used LT12, but a finer pattern of dots might look even better.

It is also possible to use Letratone on the door window, to give the appearance of a perforated metal screen there, but it is not fully transparent and the content of the oven cannot be seen when the door is shut.

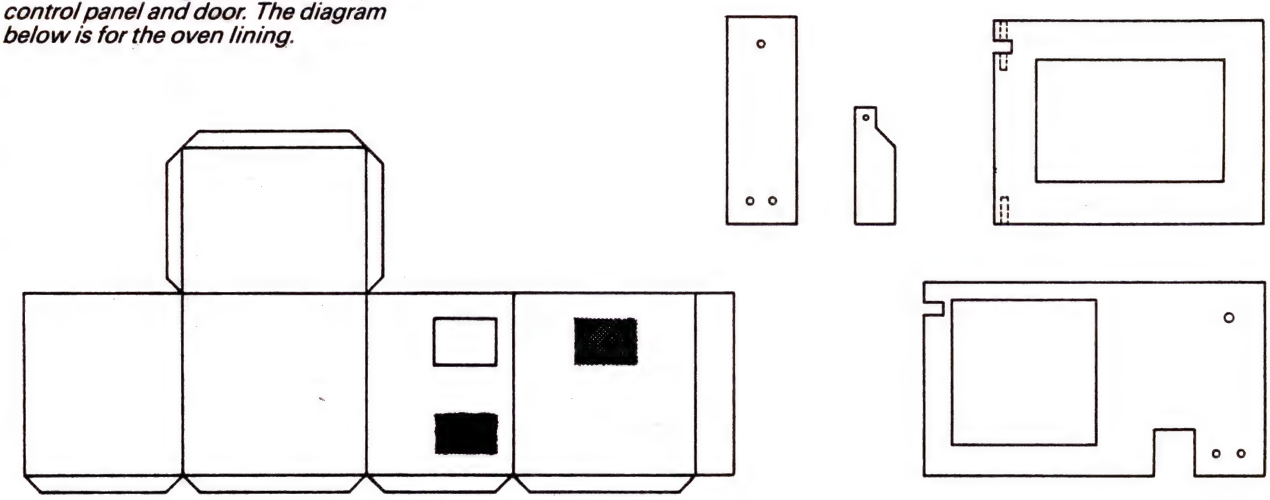
Cut two card discs to support the turntable. The easiest way is to punch discs 6mm in diameter using an ordinary paper punch. Glue one disc on top of the other in the centre of the bottom of the oven lining.

Cut a disc 23mm diameter from acetate sheet or, for preference, from colourless drafting film with a matt surface. This is the turntable, which is glued onto the supporting card discs.

Strengthen the right wall of the oven



Details of the hinge bracket, front panel, control panel and door. The diagram below is for the oven lining.



liner on the outside by gluing a 15mm x 19mm piece of stiff card to it, not covering the window. This is where the microswitch is to be fixed later. Apply glue to the front lugs and stick the oven liner to the rear of the oven front panel, aligning it with the aperture. Two squares of thick card, glued on both sides and inserted between the top and bottom of the liner and the top and bottom of the oven body, help hold the liner in place.

Glue two strips of plastic to the bottom of the oven to act as feet. Colour these black using a spirit marker.

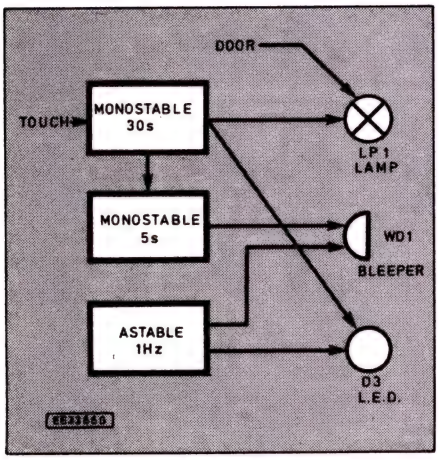


Fig. 6. System diagram for the Mini-Microwave.

HOW IT WORKS

The system diagram of Fig. 6 shows that the circuit is driven by two monostable multivibrators and one astable multivibrator. The astable oscillates at 1Hz, flashing the l.e.d. during the cooking period.

When the first monostable is triggered by a touch switch, its output goes high, turning on the lamp for 30 seconds, and allowing the l.e.d. to flash. The lamp can also be turned on by a microswitch which closes when the door of the oven is opened.

At the end of the cooking period, the output of the first monostable goes low and this triggers the second monostable. Its output goes high for five seconds. This is the bleeping period. During this period the bleeper has a potential of +6V from the second monostable at its (+) pin and an alternating 0V or 6V at its (−) from the astable. When the (−) pin is at 0V, current flows through the bleeper, which emits a bleep. Since the bleeping period is five seconds long and the astable operates at 1Hz, about 4 to 6 bleeps are heard, at one-second intervals.

The circuit diagram, Fig. 7, shows that the monostables and astable are all based on the 7555 timer i.c. IC1 is the 30s monostable, which normally has a low output. In this state it draws current through R8, D3 and D5, causing D3 to be lit continuously, independently of the state of the output of IC3.

Normally the input of IC1 is held high, by R1 but, when a finger-tip bridges the gap between the touch contacts, the resultant fall in input voltage triggers the i.c. and its output goes high. Current flows through D1 and R3, turning on TR1. The collector current of TR1 lights the lamp LP1. This can also be lit by closing S1, the door microswitch. The diode D1 prevents current flowing from the positive rail to the i.c. when S1 is closed. When the output of IC1 is high, no current is drawn through D5 and the l.e.d. is controlled by the output of IC3.

When the output from IC1 goes low at the end of the cooking period, a low pulse is transmitted across C2 to the input of IC2. This is the second monostable. Its output goes high raising the potential of

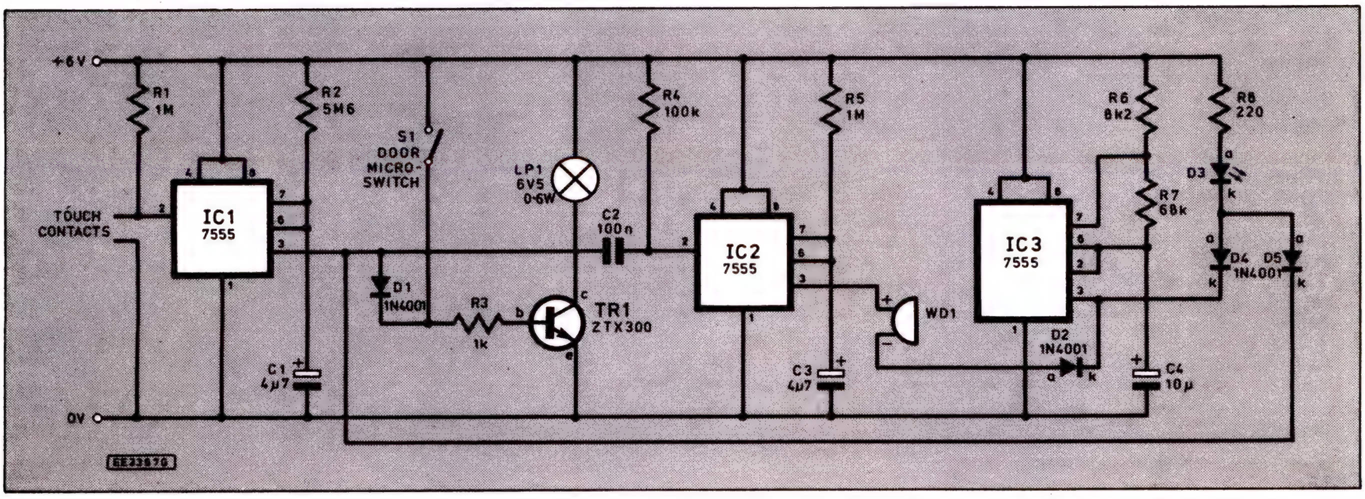


Fig. 7. Circuit diagram of the Mini-Microwave.

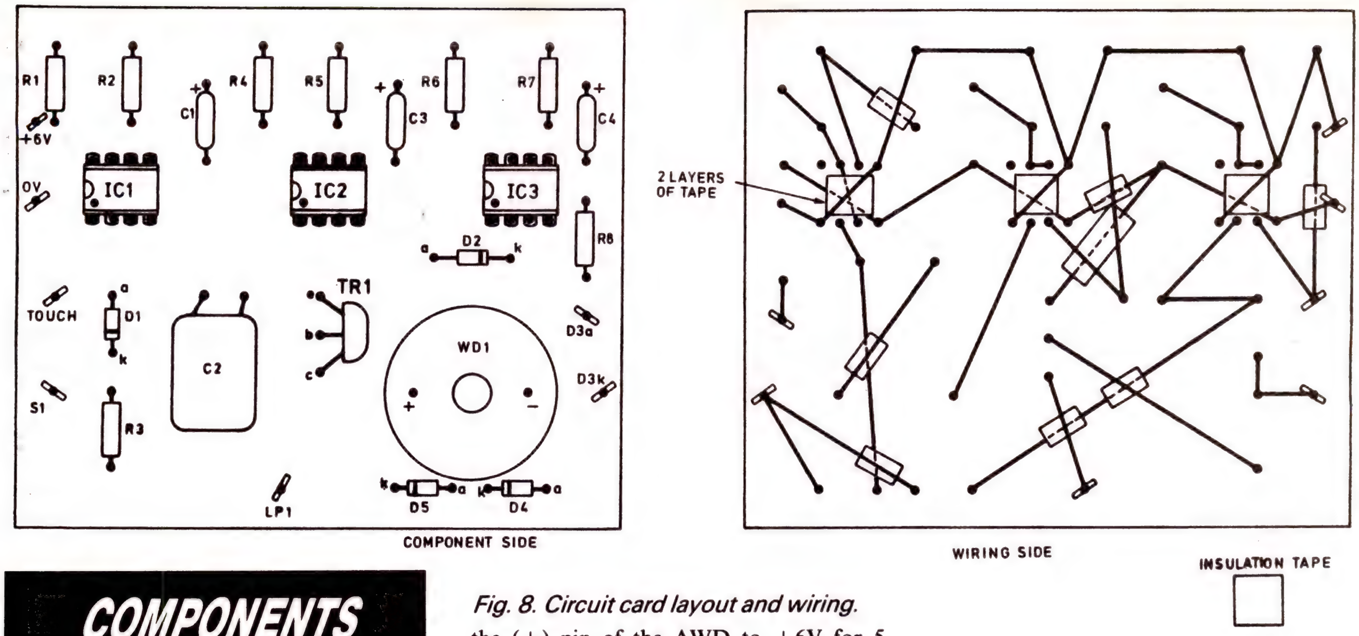


Fig. 8. Circuit card layout and wiring.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R5	1M (2 off)
R2	5M6
R3	1k
R4	100k
R6	8k2
R7	68k
R8	220 (see text)

Capacitors

C1, C3	4µ7 tantalum bead (2 off)
C2	100n polyester
C4	10µ tantalum bead

Semiconductors

D1, D2, D4, D5	1N4001 silicon diode (4 off)
D3	light-emitting diode (green)
IC1 to IC3	7555 CMOS timer (3 off)

Miscellaneous

S1	lever-operated microswitch, body approx 19 x 9 x 6mm
LP1	6.5V, 0.6W, tubular LES type with lampholder
WD1	piezo-electric sounder, frequency 2-3kHz, operating voltage 3-16V d.c., with p.c.b. pins. (flying-lead type can be used).

8-way d.i.l. sockets (3 off); p.c.b. eyelet terminals (7 off)

Materials

Printed model card – see Shop Talk and Special Offer page plus materials for the Oven and Kitchen Unit, polystyrene sheet, 2.5mm (see cutting list); polystyrene sheet, 0.5mm (see cutting list); thin clear acetate sheet, a scrap; 2.5mm x 2.5mm angle polystyrene, 320mm; tube polystyrene cement; tube clear adhesive (e.g. Bostick Clear); model gloss paint (e.g. Humbrol) in 1 or 2 colours; spirit marker pen, black; optional – Letratone, self-adhesive film, LT12 or similar (from Office or Graphic Artist's suppliers)

Approx cost guidance only **£5.50** *plus "Materials"*

the (+) pin of the AWD to +6V for 5 seconds.

The astable is formed by IC3, its output going high and low once every second. When its output is low, current is drawn through R8, D3, and D4, making the l.e.d. light. When the output is high and the output of IC1 is also high (i.e. during the cooking period), the l.e.d. goes out. Thus it flashes during the cooking period, but is continuously on at other times. The output of IC3 is also connected to the WD1(−) pin through the diode D2. When the output of IC2 is high and that of IC3 is low (i.e. during bleeping time), current passes through D2 and WD1, sounding the bleep. Diode D2 prevents a reverse current passing through WD1 at other times.

CIRCUIT CARD

The circuit is designed to work on 6V d.c., but will also work on 9V or 12V d.c. Note that a *direct* current supply is essential. Some "power packs" used with doll's houses consist simply of a transformer which produces 6V or 12V *alternating* current. Such supplies must not be used with this circuit. Suitable 6V d.c. "mains adaptors" or "battery eliminators" are available cheaply, producing 300mA of current, which is more than sufficient.

If operating on other than 6V, the only changes to the circuit are to replace R8 with a 390 ohm resistor for 9V operation or with a 560 ohm resistor for 12V operation, and to replace LP1 with a 12V lamp for 9V or 12V operation.

The whole circuit is assembled on a single card (Fig. 8) which just fits into the kitchen unit. When you have drilled or otherwise made the holes in the card, insert the i.c. sockets and WD1, first placing a spot or two of glue beneath them so that they are attached firmly to the card. Similarly, insert C2, bend it over and glue it to the card. Wiring is also shown in Fig. 8; note that there are *two* layers of insulating tape beneath IC3, where three wires cross.

TESTING

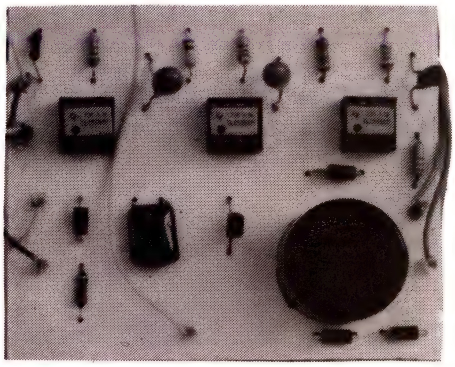
For testing, connect the card to off-board components, as in Fig. 9 except that the wires are not threaded through the holes in the oven and unit. Fix the two contact wires so that their ends are about 3mm apart. Hold the lever of S1 depressed, as if the door were closed.

Begin testing with only IC1 in its socket. When power is applied, the lamp may light for about 30 seconds. When it goes out, touch the contact wires with a finger-tip so that the gap is bridged. It may help if the finger tip is *slightly* moist. The lamp goes on for about 30 seconds. The lamp also goes on if the lever of S1 is released. If this fails to work, check the output (pin 3) of IC1, which goes high (+6V) for 30 seconds after the contacts have been touched. If this does not happen check all wiring around IC1. If the output behaves correctly, but LP1 does not light, check the wiring of D1, R3 and TR1, and also that D1 is connected the correct way round.

Disconnect the power, insert IC3 and re-apply power. The l.e.d. shines continuously. Touching the contacts turns on LP1, as before, and the l.e.d. flashes at approximately 1Hz (one flash per second). The output of IC2 (pin 3) alternates between low (0V) and high (6V) at the same rate. After 30 seconds LP1 goes out; the l.e.d. stops flashing and remains permanently on. If the l.e.d. does not light, check that it is wired the right way round and that D3 and D4 are also correctly wired.

Disconnect the power, insert IC2 and reapply power. The l.e.d. comes on as before. Touch the contacts; LP1 comes on for 30 seconds and the l.e.d. flashes. Immediately LP1 goes out, WD1 emits 4 to 6 bleeps, in time with the flashing l.e.d. The output

Photograph of the completed prototype circuit card for the Mini-Microwave.



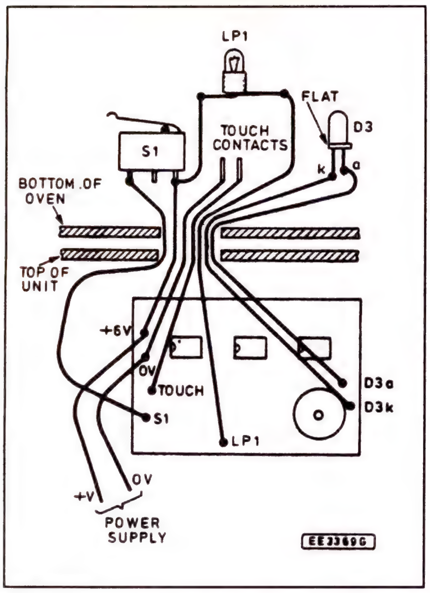


Fig. 9. Interwiring of the various off-board components.

of IC2 goes high when LP1 goes out and stays high for about five seconds. If this does not happen check the wiring around IC2. If the output is correct but WD1 does not sound, check that D2 is inserted the right way round.

Disconnect the power, insert IC3 and re-apply power. The l.e.d. shines continuously. Touching the contacts turns on LP1, as before, and the l.e.d. flashes at approximately 1Hz (one flash per second). The output of IC2 (pin 3) alternates between low (0V) and high (6V) at the same rate. After 30 seconds LP1 goes out; the l.e.d. stops flashing and remains permanently on. If the l.e.d. does not light, check that it is wired the right way round and that D3 and D4 are also correctly wired.

Disconnect the power, insert IC2 and re-apply power. The l.e.d. comes on as before. Touch the contacts; LP1 comes on for 30 seconds and the l.e.d. flashes. Immediately LP1 goes out, WD1 emits 4 to 6 bleeps, in time with the flashing l.e.d. The output of IC2 goes high when LP1 goes out and stays high for about five seconds. If this does not happen check the wiring around IC2. If the output is correct but WD1 does not sound, check that D2 is inserted the right way round.

FINAL ASSEMBLY

There is only just enough space behind the control panel to hold the microswitch, the l.e.d., the contact wires and the lamp, so this part of the assembly needs to be well thought out at all stages. First attach leads about 120mm long to the l.e.d., lamp and microswitch and twist the contact wires together (Fig. 10). Use multistranded insulated wire of as light a gauge as you can obtain. We used 7/0.15 (7 strands, 0.15 mm diameter) P.V.C. covered cable, with external diameter 1mm. Make sure that the anode and cathode leads of the l.e.d. are identifiable, either by using wire of different colours or by marking their free ends. Check that the microswitch leads are attached to the correct pair of terminals, 'common' (C) and "normally closed" (NC).

Glue the microswitch to the oven liner (Fig. 11). Depending on the exact make of switch used, you may need to glue one or two more layers of card as spacers between the switch and the stiff card. Before the glue hardens, check that the end of the lever is able to move freely and that the switch *just* clicks open when the lever is pressed flush with the front panel of the oven.

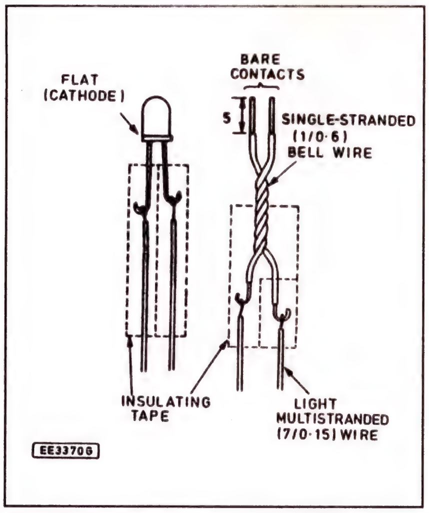

FLAT (CATHODE)
BARE CONTACTS
5
SINGLE-STRANDED (1/0·6) BELL WIRE
INSULATING TAPE
LIGHT MULTISTRANDED (7/0·15) WIRE
EE3370G

Fig. 10. Connections to D3 and the touch contacts.

Push the contact wires through the two lower holes in the control panel and glue the insulating tape binding to the bottom of the oven body. Trim the contact wires so that they project about 0.5mm from the front of the panel.

If you have a short length (a mere 5mm is enough)! of optical fibre, thread this through the upper hole in the control panel, so that its outer end is flush with the front of the panel. Glue the fibre at the rear to fix it to the panel, then glue the green l.e.d. to the other end of the fibre. If you do not have optical fibre, mono-filament nylon (fishing line) might work instead. Otherwise simply glue the l.e.d. to the rear of the oven front panel so that it shines through the hole. In either case, also glue the insulation around the leads to the top of the oven body.

Draw a miniature key-panel on paper about 8 x 13mm, and stick this to the control panel. For greater realism, photograph the key panel of a real oven and have a colour-print made to the required size. Hang the door in its hinges (Fig. 4) using steel pins, which can be cut from dressmaker's pins. If the door will not stay shut to hold S1 open, a *small* ball of Blutack inside the top right corner of the door will secure it.

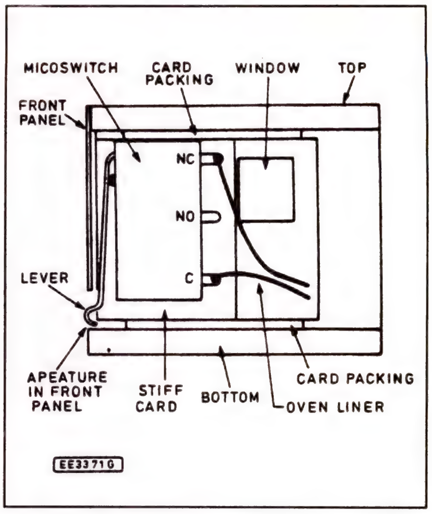
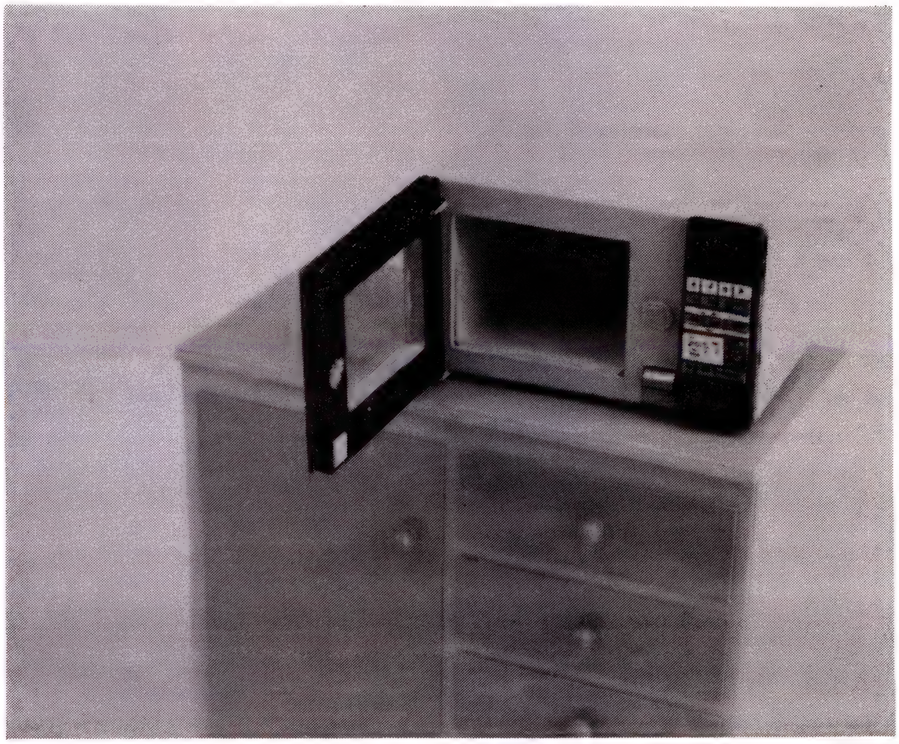


Fig. 11. Mounting and wiring of the microswitch S1.

Fix the lamp-holder with Blutack so that it is just beside the "perforated" window in the oven lining. To complete the assembly, you could secure everything firmly in place by packing the remaining space behind the control panel with pieces of plastic foam. Gather the leads together and thread them through the hole in the bottom of the oven. The rear panel is a push-fit in the rear of the oven body.

Thread the wires through the hole in the unit top. Glue the oven on top of the kitchen unit, to prevent it from sliding about. Make the connections to the circuit card (Fig. 9). Place the circuit card in the unit and then connect it to the doll's house power supply, or to a battery if this is not suitable.

The mini-microwave is now ready to cook its first meal for the occupants of the doll's house. ☐



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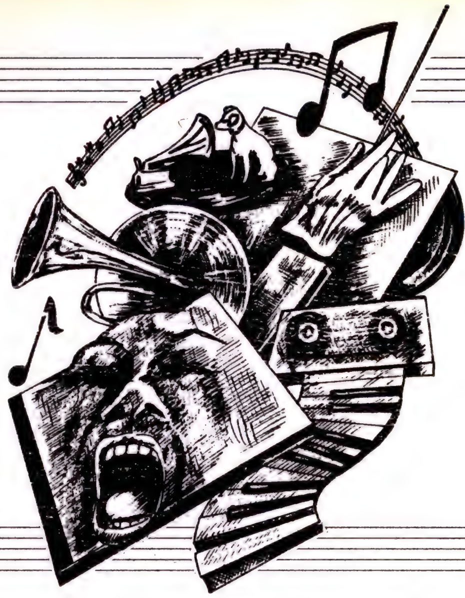
MAGNETIC RECORDING

Part 2: Recording and Playback Heads



VIVIAN CAPEL

Life today would be difficult to imagine without magnetic recording: No audio or video recorders; no computer disks; no payphone cards; no bank cash cards or magnetic security pass cards. In spite of its universal use, magnetic recording and the principles of magnetism are still little understood by most people. In this short series we hope to answer some of the questions most often asked about Magnetic Recording.

WHY IS the gap in a recording head much wider than that of a playback head? and how can it record wavelengths shorter than itself? Why do some heads last much longer than others? These are questions that often puzzle inquiring tape-deck owners, and ones we shall try to answer in this article along with a few more.

Both the recording head and the playback head are basically of the same construction, in fact a single head is commonly used for both, although the design is thereby somewhat of a compromise. Basically, the head is a ring of magnetic material having a gap filled with a non-magnetic shim. A pair of coils are wound, one on each side of the ring, through which is passed the signal current. A corresponding magnetic field thereby appears across the gap, but diverted around the outside of the shim, so that it penetrates the magnetic coating of the recording tape.

During playback, fluctuating magnetic flux from the tape is conducted from the gap in a magnetic circuit around the ring and thus induces voltage in the coils.

The coils are wound in opposite phase, although connected to reinforce each other. The reason for this is that any stray hum fields that may affect the coils are thereby cancelled out. Stereo heads have two identical rings and sets of coils mounted one above the other. The proximity and similar orientation makes coupling between them a strong possibility, which produces crosstalk and deterioration of the stereo image. To minimise this, careful screening is required.

If two separate heads for recording and playback are employed, the design of each can be optimized. Furthermore, a facility called ***AB monitoring*** can be provided. This is the playback of a tape as it is actually being recorded, a switch providing a comparison between the played back signal of the tape and the recording signal being applied to it.

Playback Head

First of all we will consider the playback head. When a complete recorded wavelength equals the width of the head gap, both negative and positive half cycles are in the gap at the same time, so they cancel and there can be no electrical output. As the wavelength increases relative to the gap width, the output rises form zero to a maximum at twice the gap width which is equivalent to one half cycle.

The gap width is therefore one of the factors that limit the upper frequency response of the head, and the smaller the width the higher the response. The response for a given width, or the width required for a specified response can be calculated according to the speed of the tape. This is $1\frac{7}{8}$ i/s or 47,500μm/s. To determine the gap in microns (g) to give a response up to a particular frequency (*f*), the formula is:

$$g = \frac{47,500}{2f}$$

So for a theoretical response up to 20kHz, the gap width must be no greater than 1.2μm.

Recording Head

Gap specifications for heads that are used only for recording, reveal widths up to ten times those for playback heads. In view of what has just been said about the effect of playback gap width on upper frequency response, these may seem incapable of recording anything above mid frequencies.

However, the recording process is rather more complex than that of playback. As we saw in the last article, any particular magnetic particle in the tape coating goes through several hysteresis cycles resulting from the applied h.f. bias, as it passes the gap. it leaves the trailing edge of the gap with a magnetic value from some part of the cycle which is determined by the superimposed audio. So, it is around the trailing edge that the final magnetic value is imparted, hence the width of the gap has no effect on the frequency.

Why though have such a wide gap? The field from any recording head gap is roughly hemispherical. Its radius is therefore proportional to the gap width. A wide gap produces a field that extends out further than one generated by a small gap, Fig. 1 illustrates the principle.

Coating thickness for a C90 cassette tape is 5μm. A head gap of around 1μm thus produces only a small penetration and most of the coating remains unmagnetized. Larger gaps utilize more of the coating which thus record a higher level and so give a better signal-to-noise ratio. Furthermore, more of the flux is longitudinal with a wide gap, so the influence of the perpendicular fringe field which partially erases high audio frequencies, is less.

From this it is evident that the width requirement of recording and playback heads are not compatible and separate heads are the ideal solution. However these are uncommon, so a compromise must be effected. As a narrow gap is essential for playback to maintain good h.f. response, the gap is a dual-purpose head must favour the playback rather than the recording function.

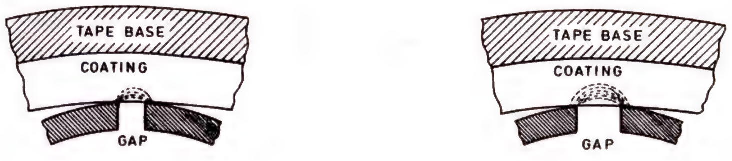


Fig. 1. A wide recording head gap produces a field that penetrates deeper into the tape coating than a narrow one because the radius of the field is proportional to it.

Losses and Frequency Response

The frequency response of a replay head including the effects of various recording and tape losses is far from flat. As shown in

Fig. 2; it consists of a large peak at around 3kHz with falling response on either side.

The amplitude of an induced signal in any conductor is proportional to the velocity of the flux cutting across it, the conductor in this case being the turns of the coils. Now the velocity of the flux is determined by the frequency, because it changes more rapidly at high frequencies than at low.

So, the amplitude falls in proportion to any drop in frequency, becoming half the level at half the frequency. Put in technical terms this is a ***6dB drop per octave*** and accounts for that decline in the response curve below the peak.

Voltages are induced in the core as well as the windings, and they cause eddy currents to circulate that do no good and so represent a loss. They are minimised in Permalloy cores by laminating them, that is building them up from a stack of thin wafers, but at very short wavelengths (high frequencies) currents are induced into each wafer. This means that ***core hysteresis losses*** as they are called, are negligible at low frequencies, but are increasingly evident at high. So they add to the falling h.f. playback response.

High frequencies also suffer during recording by the perpendicular fringe field, and by self-demagnetization of the recorded tape. The latter effect arises because successive half cycles of the recorded signal are of opposite polarity, so the successive magnetic domains are likewise opposite, which means that the sequence of poles is N – S, S – N, N – S, and so on.

Now magnets stored with like poles adjacent as in this sequence, tend to become demagnetized. The extent depends on the physical size of the magnets, short thick ones demagnitize more readily than long thin ones. The short thin domains are those that correspond to the short wavelengths of the high frequencies, so these are the ones that suffer most.

In addition to these there is also the reducing h.f. response as the playback gap width increases relative to the recorded wavelength. All these effects add up to produce that rapidly falling h.f. response above 3kHz.

Flattening It Out

It looks rather a tall order, but it can be done. The first step is known as ***pre-emphasis***, which gives some boost to the high frequencies during recording. This also helps with noise as most noise is concentrated in the upper octaves, so boosting the signal high frequencies improves the signal-to-noise ratio. If boosted too much though, the tape could saturate, so the boost must be limited. Different amounts are applied to normal ferric and to chrome tape.

The next step is ***equalisation***. This is applied to the playback amplifier and consists mostly of bass boost at the rate of 6db per octave below 3kHz. So this takes care of the falling bass response.

A certain amount of treble boost is also applied to make up the short-fall there. The amount is specified as a *time constant* which is the time that a capacitor used in the boost circuit takes to charge through a specified resistor to 63 per cent of its maximum amount. The term is a convenient way of describing the capacitor/resistor combination required to achieve a particular response.

For ***ferric tape***, the equalisation is 120µS which boosts frequencies above 1.2kHz. However, due to the influence of the bass boost, the curve does not flatten and start to climb until 3kHz which is just the point required to give an inverse curve needed to balance the response. This can be seen in Fig. 2.

In the case of ***chrome tape***, more boost can be applied in the recording pre-emphasis, and also the tape has reduced h.f. losses, so the equalisation at high frequencies can be less. It is 70µS, which starts at 2.2kHz. here again the bass boost delays the flattening out and treble boost climb which in this case commences at 4kHz.

It is remarkable that with all these losses and response deviations, and with the various boosts applied to correct them, that hi-fi is possible from tape at all. However, now we will take a look at the head core materials and how they affect performance.

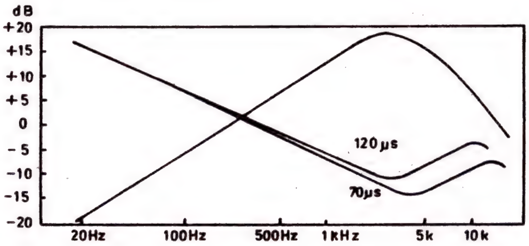


Fig. 2. Playback head frequency response having peak at 3kHz with falling bass and treble output either side. Equalisation curve compensates. The 120µS curve is used for ferric tape and the 70µS for chrome.

Permalloy

Permalloy is the most common core material being an alloy of some 78 per cent nickel and iron with a trace of molybdenum. It has the advantage of permitting a high flux density without saturating and so it can take high recording levels before distortion occurs.

However, the permeability is not constant but falls with increasing frequency. Its value at 10kHz is only a tenth of what it is at 1kHz. This is another of the reasons for the poor high-frequency performance of a Permalloy playback head.

Another effect is that it imposes a limit on the frequency of the bias signal. Ideally this should be as high as possible to avoid intermodulation with the higher audio frequencies, but must be kept low with Permalloy to reduce heavy hysteresis losses and subsequenty heating of the core. Laminating the head helps as we have seen but does not eliminate the problem.

Lamination actually introduces problems of its own which are in producing an accurately aligned head gap. With gaps of only a few microns it can be appreciated that assembling a stack of laminations so that all the gaps are perfectly in line is no easy task. Deviations effectively increase the gap width and thereby increase the h.f. loss during playback.

Permalloy is also the softest of core materials, rating 130-140 on the Vickers hardness scale. It thus wears rapidly, an average being 120µm per thousand hours. The average life is 1,000-2,000 hours. The life depends on the type of tape used, some are more abrasive than others, and also if the tape is in contact with the head during fast winding as it is with some programme search facilities.

The non-magnetic shim used to fill the gap is carefully chosen to have the same degree of wear as the core so that a uniform face is maintained during the life of the head with no high spots or cavities. For Permalloy the material is usually beryllium copper.

Sintered Ferrite

Sintered ferrite is made up of an amalgam of various different oxides, the main ones being iron oxide, zinc oxide, nickel oxide and manganese oxide. These are combined in the form of fine grains with a ceramic filter and binder to form solid blocks.

As the material is not solid metal, the flux density before saturation is just half that of Permalloy. Permeability is only a tenth of a Permalloy core but it is more consistent; the value at 10kHz being three-quarters of its 1kHz value.

The presence of the ceramic binder results in a high electrical resistance. Eddy current losses are thus very low which together with the more consistent permeability at high frequencies, means that the h.f. response of a playback head is better than Permalloy. For the same reason higher bias frequencies can be used.

Another effect of the absence of eddy currents is that the core can be made out of a solid block; laminations are not necessary, so more accurate gaps can be achieved. However, the material is brittle and chips very easily. Also tiny bubbles can form in the manufacture, which reveal themselves as cavities on the head face when machined. It is much harder than Permalloy, registering some 400 on the Vickers scale which is three times that of Permalloy. Heads therefore have a much longer life.

However, the residual magnetism of Sintered Ferrite is greater than Permalloy so requiring a larger coercive force to overcome it. This can result in a higher noise level. So, although there are advantages over Permalloy, there are also disadvantages. Some of these are avoided with HPF.

HPF

The initials HPF are for ***Hot Pressed Ferrite***. It is made by compressing ferrite at pressures of around 7,000lb per square inch (48MPa), at a temperature of 1,400°C. Permeability is greater than ordinary ferrite as may be expected from its compacted nature, but surprisingly it is also greater than the metal Permalloy.

Table of Head Core Materials

Material	*Composition*	*Permeability* 1kHz	10kHz	*Max Flux (T)*	*Coerc force (oersted)*	*Spec R (Ω/cm²)*	*Vickers hardness*
Permalloy	Ni, Fe, Mo	18,000	1,500	0.7	0.02	0.00005	135
Ferrite	Mn0, Fe_20_3, Zn0, Ni0	1,200	900	0.4	0.5	>100	400
HPF	Mn0, Fe_20_3, Zn0, Ni0	20,000	10,000	0.4	0.015	>100	700

The effect of frequency on permeability is much less than Permalloy but slightly more than ferrite. The level at 10kHz is just half that at 1kHz. Maximum flux density is the same as unpressed ferrite which as we saw is half that of Permalloy. Residual magnetism is less than ferrite and even less than Permalloy thus enabling low noise recordings to be produced.

The hardness is rated at 650-700 on the Vickers scale which is greater than ordinary ferrite. It is so hard that ***hard glass*** must be used as the gap filler. No bubbles can remain in the material due to the very high pressures used in manufacture, so no cavities can appear when it is machined. It is capable of taking a high polish which reduces tape friction and thereby also flutter effect. Wear is very low being about 0.4μm per thousand hours.

HPF is thus close to being the ideal tape head core material for ferric tapes, but the reduced maximum flux density compared to Permalloy can be a drawback for metal tape which needs high flux densities for recording and even higher ones for erasing.

As the flux density of the head core increases so does the distortion. This is mostly third harmonic as it is with the tape itself, and it can become severe as the saturation point is approached. It is not a problem with Permalloy heads and ferric tapes as tape saturation is reached long before the head core. With iron tape and to a lesser extent chrome, the high recording flux needed can drive ferrite cores well toward saturation. Even playback heads can be driven into distortion by heavily pre-recorded tapes.

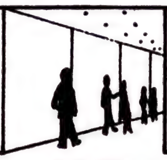
Sendust

Another core material is ***Sendust***. This has the hardness of ferrite with the flux capacity of Permalloy. The disadvantage is its low electrical resistance which like Permalloy results in eddy currents and h.f. losses as well as low bias frequencies.

The solution to this is the same as for Permalloy, that of rolling the material out into a ribbon when it is hot, then making up the head core from a stack of laminations. This of course brings back the staggered gap problem of the Permalloy head. For dual-head machines, the solution is to use Sendust for the record and erase heads in which gap size is unimportant but flux density is, and HPF for the playback head which requires an accurate gap.

In the next article we will consider the maintenance and adjustments needed to ensure top performance from a record/playback head, and take a look at tape erasure too.

SHOP TALK



with David Barrington

Car Alarm

With car crimes repeatedly hitting the headlines lately, **Electronize Design** have introduced an infra-red key-ring transmitter and a dash top receiver to deter would-be "joyriders". With a possible 59,046 codes, the system is unusual in that the user can select their own code.

The unit has a claimed range of up to 5 metres, the transmitter and receiver are priced separately at £17.95 and £26.55 respectively. With an alarm and siren added, the complete coded system retails for £77. For the D.I.Y. enthusiasts, kits are available bringing the system cost down to £62.

Electronize Design, Dept EE, 2 Hillside Road, Four Oaks, Sutton Coldfield, West Midlands, B74 4DQ. (☎ *021 308 5877*).

Darts Scorer

Some of the semiconductor devices called for in the *Darts Scorer* are special items and only appear to be available from one source.

The CMOS 8-bit microprocessor type MC146805E2P is currently only listed by **Electromail (☎ *0536 204555*)** code 642-272, and **Viewcom (☎ *081 471 9338*)**. The octal latch chip 74HC573 (code 643-512 or 631-165), the CMOS keypad switch encoder MM74C922N (code 307-907) and the Hewlett Packard low current, common anode, 0.56in. high 7-segment display (code 588-623) were all purchased from Electromail. The connections for the 7-segment display are along the top and bottom edges of the device package.

The 4.9152MHz crystal (code 657-577) and the 16-key, 4-by-4 matrix, membrane keypad (code 331-269) were also purchased from the above source. The use of this particular keypad was chosen because of the inclusion of an insert sheet carrying standard printed legends, whilst the other side of the sheet will take "rub-down" transfers (such as Letraset) enabling the keys to be customised for the scorer.

By special arrangement with the designer, a ready programmed 27C64 CMOS EPROM is available for the sum of £7 inclusive. Orders should be sent direct to: ***R. Stone, 19 Cherryfields, Poplars Farm, Bradford, West Yorks, BD2 1LB.*** A photostat copy of the complete "Hex dump" listing is available to readers from the EE Editorial Offices for the sum of £1 and a large SAE.

The case used in the prototype is a BICC-Vero case from the Appolo range size 4 (order code 75-38118E) available, money with order, from **Verospeed (☎ *0800 272555*)**. The single-sided printed circuit board is available from the *EE PCB Service*, code EE774 (see page 748).

Mini Microwave – Simple Model Series

Looking through the various components catalogues to make sure that they all stock a suitable selection of microswitches in the *Mini Microwave*, this month's *Simple Model Series* project, we notice that the sub-miniature types appear to be the only ones that have their contact tags "in-line". As space is at a premium, it is best to stick to the sub-miniature type; however there is no reason why other types cannot be used provided suitable space is allowed for in the final model.

The microswitch should, of course, be the lever operated type and the metal lever "kinked" to the required shape. This is best accomplished in gradual stages by using two pairs of long-nosed pliers and checking the switch operation on the model, before making any further adjustments.

The model and electronic circuit is built on *printed* card, which can be obtained from the EE Editorial Offices for the sum of £1 (including postage). The wiring-up of the "electronics" card is accomplished by the use of the Vero Easiwire "no soldering" wire-wrapping system.

To help with assembly, **Greenweld Electronic Components (☎ *0703 236363*)** and **Bull Electrical (☎ *0273 203500*)** have put together a complete kit, including cards, for the sum of £5.50 plus £1 postage. – See *Special Offer* page 721.

The above mentioned companies have large stocks of the Easiwire solderless wiring packs and have agreed to make these available to EE readers who order kits from them. If you purchase any one *single* kit an Easiwire pack will set you back just £5. However, if you are prepared to order four or more of the kits listed they will supply an Easiwire kit FREE.

Modular Disco Lighting

We do not expect any component buying problems to be encountered by readers undertaking the *Superchaser* or *Supersweep*, this month's concluding projects for the *Modular Disco Lighting System*.

The specified metal instrument case for both modules is the same for all modules in the series and is the Maplin Blue case 233, code XY48C. Other cases may be used, but, for safety they *must* be METAL and it is essential that the case be "Earthed".

The 7-way DIN plugs and chassis mounting sockets are standard items stocked by most of our component advertisers. However, the 10-pin circular "video" chassis mounting plug, with matching cable mounted socket, may prove to be difficult to locate from a local source. The one used in the models was purchased from **Electromail**. To some, these may seem expensive and readers may wish to use alternatives but bear in mind that they should be indentical for all modules to enable them to be interconnected within the system.

The double-sided printed circuit boards for both projects are available from the *EE PCB Service*. Quote codes EE771 (Superchaser) and EE772 (Supersweep).

Remote Camera Release

Looking down the components list for the *Remote Camera Release*, the motorised gearbox is the only item that stands out as one that will cause readers problems trying to find a local supplier. The only source we have been able to find is from **Magenta Electronics** and is their larger unit type MGL.

The 40kHz ultrasonic transducer for the transmitter and receiver circuits are nearly always sold as matched pairs and should be stocked by most of our component advertisers. The 6V 100 ohm coil 5A relay used in the prototype model is the Maplin JM17T (6V/5A Min Relay). Other relays can, of course, be used but must be suitably rated and sit on the circuit board as space is limited inside the case.

Bicycle Alarm

The mercury vibration switch used in the *Bicycle Alarm* is available from Maplin, code UK57M. The metal case of the switch is also one of the switch contacts and a lead must be soldered to the casing as indicated. It is important that the soldering iron bit is held against the casing no longer than absolutely necessary to make a good joint.

The high power buzzer should be available generally and is the type which will operate from 3V to 24V d.c. at a resonant frequency of about 3kHz. Be careful when ordering the BC184L transistor, make sure that it carries the suffix ***L*** as other types have a different pinout alignment.

The small printed circuit board for the alarm is obtainable from the *EE PCB Service*, code EE773 (see page 748).

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DOWN TO EARTH

George Hylton

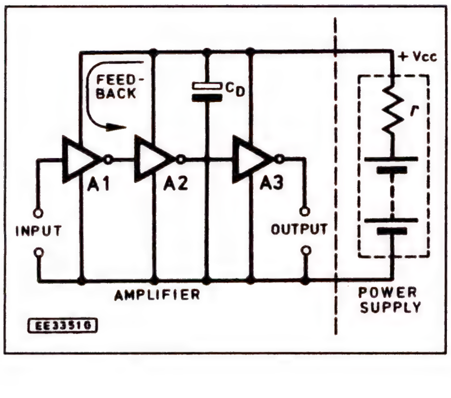
SOMETIMES a circuit which is intended to be an audio amplifier turns out to be a low frequency oscillator. The loudspeaker emits a sound which can be anything form a loud ticking or regular thumping to a hideous pulsating throb, which accounts for the name of the effect: *motorboating.*

There are several possible causes. In classical motorboating (Fig. 1) the basic cause is the resistance (*r*) of the power supply. If there are three inverting stages, as shown, a voltage across *r* may be fed back via the $+V_{cc}$ connection to the output of A1, e.g. via a collector load resistance. It is subsequently amplified and inverted by A2 and A3 to set up more voltage across *r.* If this is in phase with the original voltage, feedback is positive and the circuit may oscillate.

With two inversions the voltage fed back is indeed in phase, so if the gain is high enough (or *r* high enough) oscillation does occur. Of course, there is also feedback via A2 and A3 but stray signals there aren't amplified so much, so they don't actually have much influence.

The obvious remedy is to reduce *r* to the point where there isn't enough feedback to cause a problem. Occasionally, the motorboating can be stopped by increasing the decoupling capacitance C_D. However, if the amplifier has a good l.f. response this may call for such a large capacitance as to be impracticable. Restricting the bass response may cure the trouble, but perhaps at the expense of fidelity.

Fig. 1. Classical motorboating is caused by accidental feedback via the internal resistance (r) of the power supply.



PRACTICAL EXAMPLE

This kind of motorboating has become much less of a problem since the advent of integrated-circuit a.f. amplifiers. These are usually designed round an op-amp-like differential amplifier circuit. This usually has very low sensitivity to stray voltages on the power supply lines. (In op-amp parlance it has a high power-supply rejection factor.) It is also fairly standard, nowadays, to stabilise V_{cc}. Most voltage stabilisers have very low output resistance, so their use ensures a low *r.*

However, motorboating can still be a problem in simple low frequency amplifiers using discrete transistors. In typical cases the problem arises when there are three stages, but two-stage bipolar circuits can motorboat if voltages on the power supply can reach the input. One possible countermeasure is to add one more stage. This introduces a further phase inversion which turns the positive feedback into negative feedback.

Four stages provide far too much gain for any normal application. However, the final stage can be a unity-gain emitter follower. This doesn't invert the wanted signals but does invert the power-supply disturbance, since *r* is its collector load. So it improves stability, in theory.

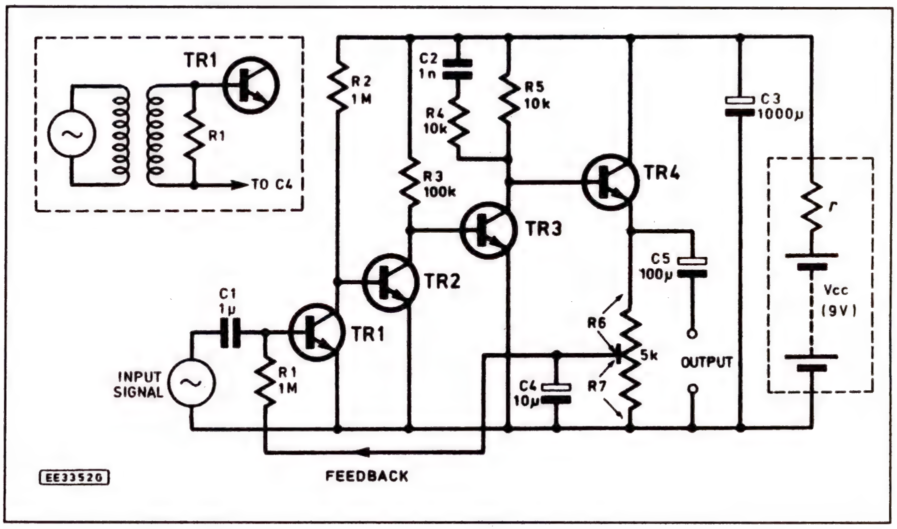


Fig. 2. High gain amplifier. A second motorboating mode is possible. Component values are typical. C2 and R4 help to avoid high frequency instability.

A representative circuit is shown in Fig. 2. Unfortunately, anyone who builds this sort of amplifier discovers that it is still very liable to motorboating!

PHASE SHIFT MOTORBOATING

The trouble arises because the Fig. 2 type of circuit contains a new mechanism for provoking motorboating. This is feedback via the bias network R6, R7, R1. Clearly, voltages at the base of TR4 set up an emitter current through the potentiometer (R6 + R7). Voltages across R7 cause current to flow via R1 to TR1 base.

On the face of things this feedback is negative, because with three inverting stages the output at TR4 emitter is in anti-phase with the input at TR1 base. Unfortunately, the decoupling capacitor C4 causes phase delay. Also, C1 is earthed via the input-signal source. In conjunction with R1 this causes a further delay. There must also be some delay in the passage of signals through the transistors. The combined effect of all these delays is to shift the phase of signals fed back from TR4 to TR1 via the bias network.

At some frequency, the phase shift is 180 degrees. This turns what should be negative feedback into positive feedback. If there is enough gain the circuit oscillates.

This sort of motorboating can be difficult to cure without drastically reducing gain. But the whole point of using an amplifier with three gain stages is to obtain very high gain. If C4 is omitted, thereby removing one cause of phase shift, the amplifier may be stable but there is now overall negative feedback of wanted signals. This drastically reduces both gain and input impedance.

Generally the best plan is to try different values of C1 and C4 to see if some combination gives stability and an acceptable frequency response. A good bet is to make C4 as small and C1 as large as practicable.

INPUT TRANSFORMER

If an input transformer can be used, the problem is eased. The secondary is connected across R1, and C1 is omitted (see inset diagram). This removes the R1C1 phase shift. A variation, used in early designs of transistor hearing aid, was to connect a dynamic microphone across or in place of R1.

These procedures may still fail in really high gain circuits, forcing the designer to use a two section circuit with a pre-amplifier and a separate main amplifier, each with its own stabilised supply.

BASS LIFT

It is not often necessary to use circuits with as high a gain as Fig. 2 provides. The risk of phase-shift motorboating is less with lower gain circuits. However, the phase-shift mechanism can still cause problems even when there is no motorboating.

In the much-used two-stage circuit of Fig. 3, there are two phase-lags caused by C2 and C1 and the associated resistance. Their combined effect is to cause

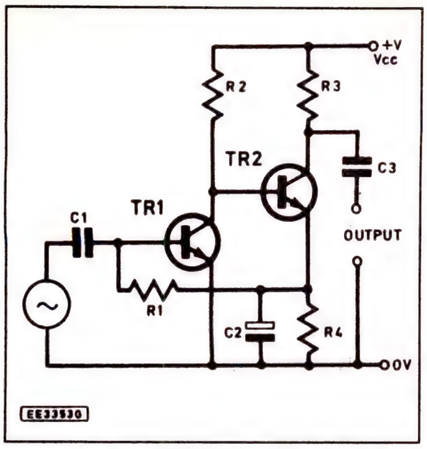


Fig. 3. In this popular circuit the bass response is influenced by C1, R1, C2, R4.

the biasing feedback from TR2 emitter to TR1 base to be not properly negative to a.c. signals. This can result in a hump in the bass response, possibly at a sub-audio frequency, giving vulnerability to rumble and "needle-dropping" transients.

SQUEGGING

There is a third type of motorboating. If an amplifier breaks into high-frequency oscillation the amplitude builds up until limited by overload. It can happen that the oscillation chokes itself off in some way, then, (usually after a capacitor which was charged during build-up had discharged) starts up again. And so on, at regular intervals.

The high frequency may be quite inaudible, but the effect of the periodic choking-off (often called "squegging") can cause intense low-frequency noise which may closely mimic classical motorboating. The remedy is to eliminate the h.f. feedback. A network like C2, R4 in Fig. 2 may help.

TRANSIENT MOTORBOATING

If a bipolar transistor is driven by a very large signal its collector voltage may fall, during signal peaks, practically to zero. In this, the "bottomed" condition, it no longer acts as a transistor. The signal peaks which cause the bottoming pass internally from base to collector where they appear without the usual phase inversion. In the negative feedback amplifier, this loss of inversion in one stage can transform the negative feedback into positive feedback and so promote oscillation.

The oscillation is often not continuous, because it stops as soon as the overloaded transistor comes out of the bottomed state. The result can be a puzzling form of distortion.

At low audio signal levels the circuit behaves as it should. As the signal increases to the point where peaks cause bottoming the circuit goes through one cycle of motorboating on each overload.

The audible effect is much worse than ordinary peak clipping because the duration of a cycle of motorboating is quite long. During this cycle the amplifier is paralysed, and a short passage of the audio signal is lost. To avoid this the designer must ensure that when the inevitable overload peaks do occur they don't cause bottoming inside a negative feedback loop.

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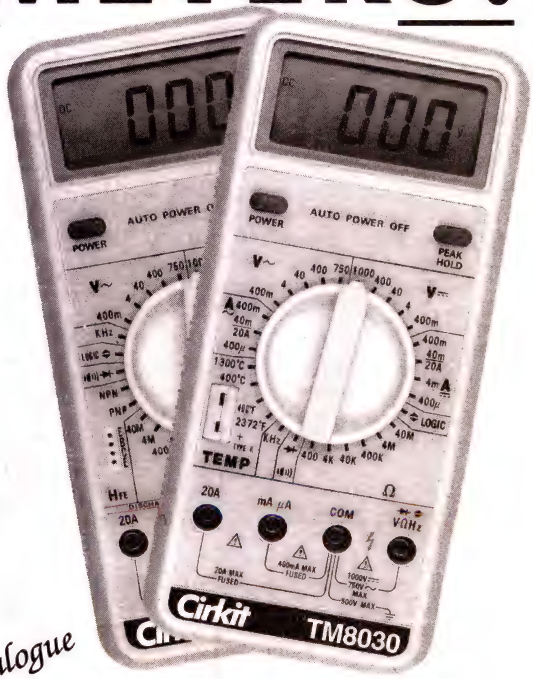

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Constructional Project

MODULAR DISCO LIGHTING SYSTEM

Part Seven: SUPERCHASER & SUPERSWEEP

CHRIS BOWES

Light up your party or disco road show with these easy-build modules.

THE Superchaser and Supersweep modules of the *Modular Disco Lighting System* are designed to include a number of very sophisticated facilities, whilst being based on the same sequences as those described earlier in this series for the Sweeper and Chaser modules in the June 1991 Issue. The modules featured in this concluding article take the basic sequences used by those modules and increase the sophistication of them by adding External Pulse, Manual Pulse, Automatic Sprint, Automatic Reverse, Automatic Pattern Change and Masterlink control facilities.

CIRCUIT DESCRIPTION

The basic operation of the two circuits is somewhat similar so only the Superchaser Module is described in full. Even if your intention is to construct only the Supersweep Module it is important to read through the description for the Superchaser circuit as well.

SUPER-CHASER

The full circuit diagram for the Superchaser module is shown in Fig. 1. The power to operate the circuit is obtained from the output module(s) to which the effects module is connected. As two sources of connection are potentially available, the negative (0V) connections at pin 8 of the two output "plugs" PL1/PL2 are commoned together on the printed circuit board (p.c.b.). The incoming positive supplies from pin 7 of the output chassis mounted plugs are connected to power the circuit via the two diodes D1 and D2.

The diodes are included in the circuit to prevent problems which might otherwise arise, should a fault or reversed connection occur in one of the output connections or the module to which it is connected. Fuse FS1 is used to give protection to the components in the event of a fault arising on the p.c.b.

The outgoing positive supply required to power the Masterlink Module is fed to the Masterlink DIN sockets SK1/SK2, pin 1's, via diode D3, whilst both pin 2's of the Masterlink sockets are connected to the common 0V points on the p.c.b.

In common with all of the other modules in this series capacitor C1 is a tantalum capacitor, which is used to provide decoupling for the i.c.s in the module. The l.e.d. D4, and it's associated dropping resistor, R1, are included to indicate that power is being supplied to the module.

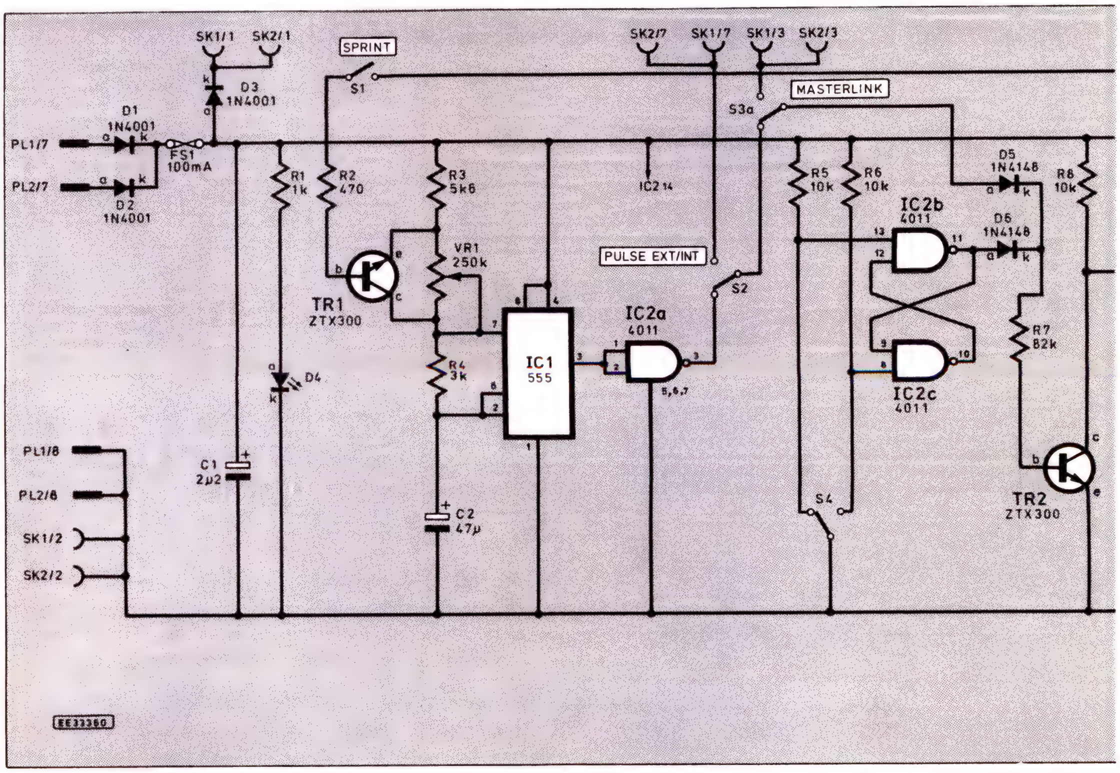
CLOCK CIRCUIT

The basic chase sequence is generated by IC3, which is a 4017 Johnson Counter. This counter is pulsed by the high-to-low transition of the CP_1 input (pin 13) as long as the CP_0 input (pin 14) is held in the Logic 1 state by means of resistor R9.

The required pulse is supplied by the operation of transistor TR2, which is made to conduct by whichever pulse source is connected to it. When TR2 is not conducting the pull up resistor R8 holds pin 13 of IC3 in the Logic 1 state.

As soon as a positive voltage is applied to resistor R7 then the action of current so supplied, flowing through the base/emitter junction of TR2, causes the transistor to conduct. This in turn causes a current to be drawn through R8 causing the logic state at pin 13 of IC3 to change from Logic 1 to Logic 0.

The pulses used to drive this circuit can be obtained from one of several sources at a time, the source being selected by the positions of switches S2, S3a and S4. In independent use the primary source of these pulses is the output of IC1. This is a CMOS 555 timer configured as an astable.



In the configuration shown a series of pulses are produced by IC1, at a frequency determined by the values of R3, VR1, R4 and C2. The values given in Fig. 1. have been selected to give a wide range of pulse speeds, depending on the setting of VR1.

As the pulses produced by this section of the circuit are predominantly in the Logic 1 state the output of IC1 is inverted by means of IC2a, which is one quarter of a 4011, quad, two-input NAND gate, with both of it's inputs commoned so as to make an inverter. This inversion is necessary so as to avoid the signal from the other internal source of pulses (the One-Shot Circuit) being masked by the output of IC1.

The pulses from the output of IC2a are fed, via the routing switches S2 and S3, to the base of TR2 through the diode D5 and resistor R7. Diode D5 and it's partner D6 form a simple OR gate which allows the transistor to be fed with pulses both from the selected source and the One-Shot.

BASE PROTECTION

Resistor R7 is included in the circuit as a "base protection" resistor. This prevents the direct connection of the base of TR2 to the positive voltage rail, were this to happen severe damage would be caused to the transistor and the source of the current. The routing switches S2 and S3 are used to replace the input to TR2 with the signals derived from either the Masterlink Module or a selected Sound Module via the Masterlink connections.

As IC3 is clocked each of it's outputs O_0 to O_4 are made to go, in turn, to the Logic 1 state. The outputs O_0 to O_3 are used to provide the signals which are used to activate the outputs of the module as shown in Table 1, whilst output O_4 is connected to the Master Reset input (pin 15) of IC3. This signal is used by the internal circuitry of IC3 to reset the counter, so that to the state output O_0 is once more in the Logic 1 state. This resetting action happens in such an incredibly short space of time that it appears to be instantaneous and makes the circuit perform as a four stage counter as shown in Table 1.

The output of the reset connection to pin 15 of IC3 is also fed to the CP_1 input of one half of IC4, which is a 4520 Dual BCD counter. The two counters in this i.c. are wired together in a cascade formation so as to give a 256 stage binary counter. The outputs from this counter are used to provide the signals which are used to drive the Sprint, Reverse and Pattern Change circuits, when selected to their Automatic functions, by means of switches S1, S5 and S6 respectively.

SPRINT CIRCUIT

The output from pin 11 of IC4 is taken, via switch S1 and resistor R2, to the base of transistor TR1. This is connected in an unusual configuration. The effect of this is that when the voltage at the base (b) of the transistor is higher than the voltage to the collector (c) the transistor saturates and effectively shorts out VR1.

This causes the frequency of the pulses generated by IC1 to be governed solely by the values of resistors R3 and R4, as though VR1 had been turned to it's minimum setting. This produces a Sprint facility such that when this signal is present the circuit runs as fast as possible, returning to the speed set by VR1 when the signal is absent.

REVERSE AND PATTERN CHANGE

The operation of the reverse and pattern switching circuits is accomplished by means of a similar system to that which is used to provide the pulse inputs to IC3. This rather complex method is necessary because of the need to switch the circuits with signals, at logic levels, from a number of sources.

The basis of this method of operation is to use a pull up resistor, switched by a transistor as typified by the action of TR4 and it's associated resistors R12 and R13. R13 is a pull up resistor which is connected so that a current may be drawn through it by the action of TR4 when required.

When no current flows through the transistor, resistor R13 acts to pull the voltage at it's junction with the collector of TR4. This causes a Logic 1 state to be present at the junction of R13 with the collector of TR4.

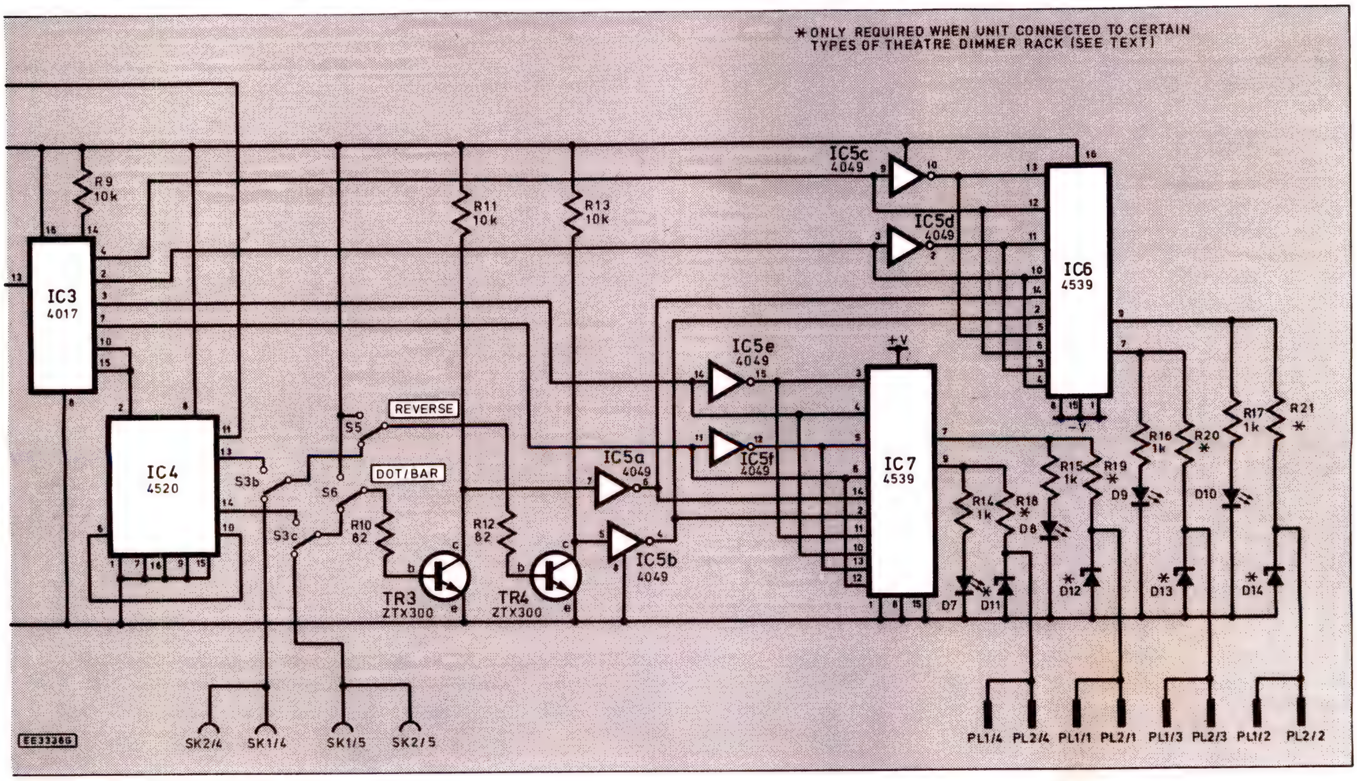
When a current is allowed to flow through the base/emitter junction of the transistor, by the connection of a voltage source to resistor R12, the transistor conducts and effectively shorts the junction of R13 and the collector of TR4 to 0V. This causes the logic state at this point to change to the Logic 0 state.

This method of operation in effect inverts the sense of the control signals. The logic

Table 1: Output Sequence for Supercharser Module

Step	IC3 Active Output	Module Active Outputs			
		Dot Mode	Bar Mode	Reverse Mode	Reverse Bar Mode
1	O_0	1	2, 3, 4	4	1, 2, 3
2	O_1	2	1, 3, 4	3	1, 2, 4
3	O_2	3	1, 2, 4	2	1, 3, 4
4	O_3	4	1, 2, 4	1	2, 3, 4
5	O_4	Reset IC3 to make O_0 active No Display Showing			

Fig. 1. Circuit diagram for the Superchaser. The front half, on the opposite page, also applies to the Supersweep.



Front panel control layout of the Superchaser Module.

states are therefore buffered and inverted by being fed to IC5a and IC5b which are each one sixth of a 4049 Hex Inverting Buffer.

Thus the switching action operates by the presence or absence of a voltage, routed by the appropriate switches. Depending on how these switches are set, the input to the transistor switching circuit can be connected to anything (permanently off) connected to the positive voltage line (permanently on) or connected to the outputs of other circuits such as the Masterlink outputs or the internal automatic sequencer counter (IC4).

REVERSE MODE

In the Reverse mode of operation the output sequence is altered so that instead of going 1, 2, 3, 4, 1 ... the pattern is reversed to go 4, 3, 2, 1, 4 ... and so on. In the Pattern Change mode the outputs of the module are made to be in accordance with Bar mode pattern, shown in Table 1, with three outputs being active instead of one.

In effect this is the inverse of the Dot Mode, since in the Bar mode the outputs are all on except for the output which would be on in the Dot mode. In order to achieve this outputs O_0 to O_3 of IC3 are inverted by IC5c, IC5d, IC5e and IC5f before being applied to the switching circuit.

The selection of which of the four possible output modes is in operation is achieved by means of IC6 and IC7. These are both 4539 dual, four-input multiplexers. These are connected in a slightly unorthodox way in order to facilitate the manufacture of the p.c.b., with IC6 governing the switching of outputs 2 and 3 of the module and IC7 being used to switch outputs 1 and 4. The use of this configuration saves much cumbersome track routing since the reverse pattern connections switch around the signals to outputs 1 and 4 and 2 and 3 respectively.

The inputs I_0 to I_3 of IC6 and IC7 are fed with the outputs of the normal and inverted outputs from IC3 and IC5c to IC5f in such a way that with both TR3 and TR4 unenergised the outputs of the Multiplexers are connected to the I_0 inputs. These are fed directly from the outputs of IC4 so the module's outputs are sequenced in accordance with the "dot mode" Table 1.

If transistor TR3 is energised this causes a change in the logic state at pin 4 of IC6 and IC7. This switches the outputs of the multiplexers to be connected to the I_1 inputs. These are connected to the inverted outputs of IC3, which are available at the outputs of IC5c, ICd, ICe, and ICf. The module's outputs therefore follow the Bar mode sequence shown in Table 1.

Transistor TR4 is similarly used to provide the reverse pattern sequence by switching the logic states of pin 2 of IC6 and IC7. This activates the multiplexers to follow the states of inputs I_2 and I_3 (depending on whether TR3 is active or not).

The connections to these inputs are the same as those to the I_0 and I_1 inputs except that the pattern is reversed by the multiplexer. This connects the outputs of the module so that output 1 is now driven by the signals which would previously have driven output 4, and output 2 is now fed with the signals which would have driven output 3, output 3 is now driven with the signals which would have driven output 2 and output 4 is now driven with the signals which would previously have driven output 1.

The operation of these circuits is controlled by means of the switches S5 and S6 so that the input to the transistor switches used to set the logic levels to the multiplier may be permanently at Logic 1, permanently disconnected or under the control of the outputs of IC4.

ONE SHOT CIRCUIT

As well as being pulsed by the internal clock (IC1) or the outputs from the Masterlink module, the Superchaser Module can also be stepped through it's sequence by means of the manually operated One-Shot circuit, comprising S4, IC2b, IC2c, R5 and R6. This is essentially a standard logic "Anti Bounce" circuit, the use of which is necessitated by the need to avoid several pulses being generated by the high speed bouncing action of the contacts of the push-to-changeover one-shot switch, S4.

When switch S4 is operated the output

COMPONENTS

SUPERCHASER

Resistors

R1	1k	R5, R6, R8, R9	10k (4 off)
R2	470	R7, R10, R12	82k (3 off)
R3	5k6	R11, R13	10k (2 off)
R4	3k	R14-R17	1k (4 off)
		R18-R21	See Text

All 0.25W 5% carbon film

Potentiometer

VR1	250k rotary carbon, lin.

See SHOP TALK Page

Capacitors

C1	2μ2 tantalum, 25V
C2	47μ radial elect., 25V

Semiconductors

D1-D3	1N4001 1A 50V rec. diode (5 off)
D5, D6	1N4148 signal diode (2 off)
D4	Standard Red l.e.d.
D7-D10	Standard Orange l.e.d. (4 off)
D11-D14	Zener diode (see text)
TR1-TR5	ZTX300 *npn* silicon transistor (5 off)
IC1	555 CMOS timer
IC2	4011 Quad 2-input, NAND gate
IC3	4017 10-step Johnson counter
IC4	4520 Dual binary counter
IC5	4049 Hex inverting buffer
IC6, IC7	4539 Dual 4-input Multiplexer (2 off)

Switches

S1	Min. s.p.s.t. toggle
S2	Min. s.p.d.t. toggle
S3	4-pole changeover Min. toggle
S4	Min. s.p.d.t. push-to-changeover
S5, S6	Min. s.p.c.o. toggle

Miscellaneous

FS1	100mA 20mm fuse and p.c.b. fuse clips
PL1, PL2	10-way "video" chassis mounting plug, with matching cable mounted socket (2 off)
SK1, SK2	7-pin DIN 180° DIN chassis mounting socket, with matching plug (2 off)

Aluminium instrument case (Maplin "Blue Case 233", size 250mm x 150mm x 75mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket; 16-pin d.i.l. socket (5 off); plastic knobs for VR1 and S4; self-adhesive p.c.b. stand-off pillars (4 off); connecting wire; solder pins; l.e.d. clips; nuts and bolts for sockets; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE771.

Approx cost guidance only **£30** *plus case*

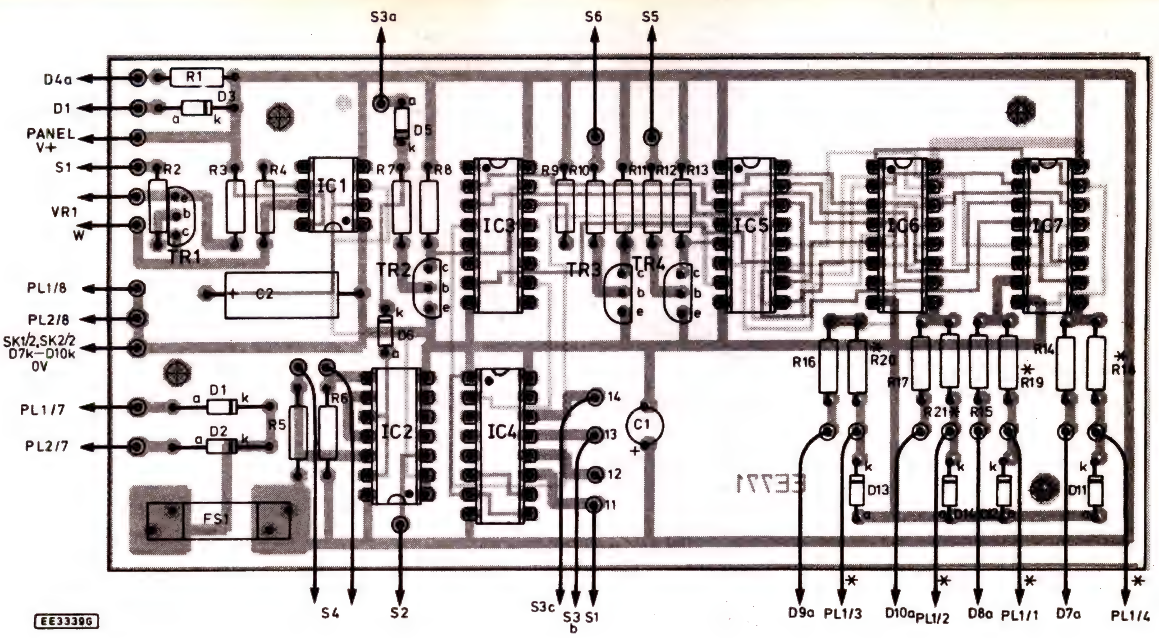
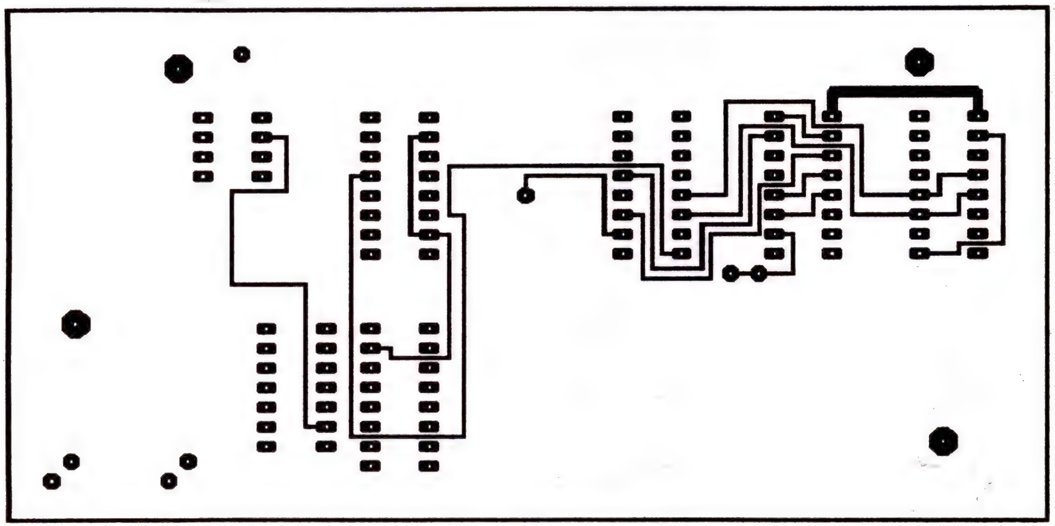
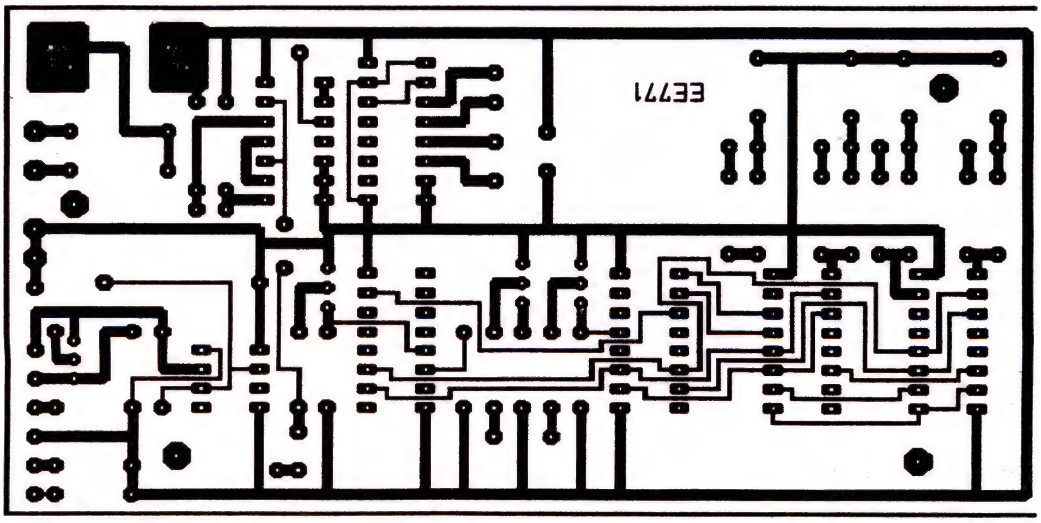


Fig. 2. Printed circuit board (double-sided) component layout for the Superchaser.



Full size copper foil track master pattern for the top, component side.



Full size copper foil track master pattern for the board underside.

from IC2b goes to the Logic 1 state and remains there until S4 is released, at which point it reverts to the Logic 0 state. The output from this circuit is fed, via diode D6, to transistor TR2 which operates as previously described.

EXTERNAL SIGNALS

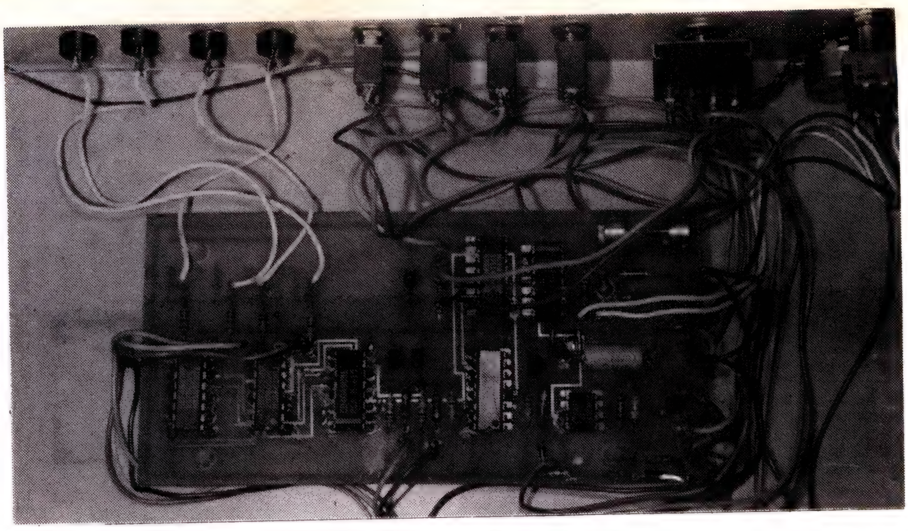
Switch S3 is used to transfer the source of the control signals to the functions of the module from those internally generated to those generated by the Masterlink module. When S3 is in the normal (up) position, the signals used to pulse the chaser circuit and operate the Auto Pattern Reverse and Auto Pattern Change circuits are derived from the internal sources within the Superchase module. When the Masterlink switch is in the on (down) position, control of these functions is transferred to the Masterlink module.

In a similar way switch S2 is used to transfer the source of the clock pulse from that generated internally by IC1 to that bussed through the Masterlink cables from a "sound operated" source, such as the VU Module described last month.

OUTPUT CIRCUITS

The outputs from the two multiplexers (IC6, IC7) are fed to the appropriate pins of the output sockets and to the orange indicator l.e.d.s (D7 to D10) which are wired in series with their respective current limiting resistors (R14 to R17) to indicate the state of the outputs of the module. The Zenner diodes (D11 to D14) and their associated resistors are included in the circuit to prevent complications arising in the event of direct connection of the effects modules to certain types of proprietary Theatrical Dimmer Racks.

If the module is to be used solely with other modules from this series then these components can be omitted. In this case the connections to the module's outputs should be taken from the multiplexer outputs on the p.c.b.


Completed circuit board and wiring to front panel l.e.d.s and switches.

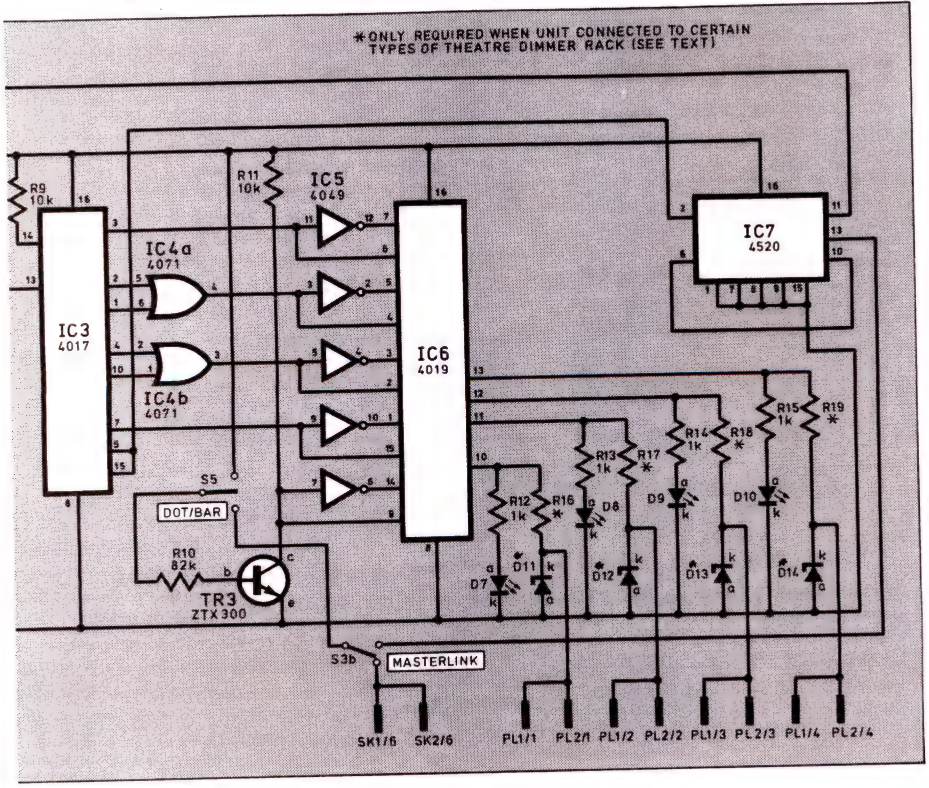
SUPERSWEEP

The output circuit diagram for the Supersweep appears in Fig. 3. Since much of the circuit, e.g. the power supply, pulse production, output and "Auto sprint" circuitry is similar to that of the Superchaser these details have been omitted from this description. For information about these aspects of the circuitry you should read through the previous section, which describes the Superchaser circuit in full.

The major differences in the operation of the Supersweep module is the order in which the outputs are switched. The basic sequence of operation of this module is that the outputs operate as a 1, 2, 3, 4, 3, 2, 1, 2 ... sequence, as shown in Table 2.

This sequence requires seven steps, rather than the five required for the Superchaser. This sequence is derived from a 4017 Johnson counter (IC3) with the outputs O_0 to O_5 being used to drive the outputs of the module and output O_6 connected to the MR input (pin 15) to reset the counter with O_0 in the logic 1 state.

Fig. 3. Output circuit diagram for the Supersweep (See Fig. 1).



This is relatively simple to achieve in the cases of module outputs 1 and 4, which can be directly fed from outputs O_0 and O_3 of IC3 respectively. Module outputs 2 and 3 are slightly more complex, since in each case they are switched on by two outputs from IC3.

Table 2: Output Sequence for Supersweep Module

Step	IC3 Active Output	Module Active Outputs	
		Dot Mode	Bar Mode
1	O_0	1	2, 3, 4
2	O_1	2	1, 3, 4
3	O_2	3	1, 2, 4
4	O_3	4	1, 2, 4
5	O_4	3	1, 2, 4
6	O_5	2	1, 3, 4
7	O_6	Reset IC3 to make O_0 active No Display Showing	

It is not possible to directly connect two outputs from a logic i.c. in parallel, since this will cause damage to the internal circuitry of the i.c. It is therefore necessary to combine the two outputs from IC3 which are required to operate the module outputs by means of a two-input OR gate, one gate being used for each output.

In the Supersweep circuit these are IC4a and IC4b. Each of these is one quarter of a 4071 quad, two-input, OR gate. Thus the OR gate IC4a, which is used to act as a source of the signals used to drive output 2 of the module is connected to outputs O_1 and O_5 of IC3, whilst IC4b, which provides the signals used to drive module output 3, is connected to outputs O_2 and O_4 of IC3.

DOT/BAR

The Supersweep module can also be switched to provide two alternative output patterns. These are referred to as "Dot" (one output active) and "Bar" (three outputs active) as shown in Table 2.

In essence the "Bar" mode is the inverse (or NOT function) of the "Dot" mode. It is therefore very easy to produce the required signals, simply by inverting the "Dot" signals to provide the "Bar" output and switching the output circuits appropriately. In this circuit IC5a, IC5b, IC5c and IC5d, which are each one sixth of a 4049 Hex Inverting Buffer i.c., are used to provide this function.

The switching function, which determines whether the outputs are in the "Dot" or "Bar" mode is achieved by the use of IC6.

This i.c. has four outputs, each of which is switchable between an "A" or "B" input. In order to provide the required effect all of the direct signals from the outputs of IC3, IC4a and IC4b are connected to the A inputs and the inverted signals obtained from IC5a, IC5b, IC5c and IC5d are connected to the B inputs.

Whether the outputs are connected to the A or B inputs is determined by the states of the switch selector (S_A and S_B) inputs to the Multiplexer. If the S_A input is at the Logic 1 state and the S_B input is in the Logic 0 state then the outputs (O_0 to O_3) follow the states of the A inputs (A_0 to A_3). If input S_B is at the Logic 1 state and the S_A input is in the Logic 0 state then the outputs (O_0 to O_3) will follow the logic states of the B inputs (B to B_3).

A problem, leading to unacceptable output states with either all channels on or all channels off, would arise should the S_A and the S_B inputs be both at the same logic state. In order to prevent this happening a single signal is used to drive both inputs with an inverter (IC5e) being interposed in the connection to pin 14 (S_B) of IC6. This ensures that the S_A and S_B inputs to IC6 are always in the opposite logic states.

The signal which is used to determine the logic states at the switch inputs of IC6 is derived from the connection of resistor R11 and transistor TR3. This operates in exactly the same way as is used for all of the rest of the pattern switching operations of the

COMPONENTS

SUPERSWEEP

Resistors

R1	1k
R2	470
R3	5k6
R4	3k
R5, R6, R8, R9, R11	10k (5 off)
R7, R10	82k (2 off)
R12-R15	1k (4 off)
R16-R19	See Text

All 0.25W 5% carbon film

Potentiometer

VR1	250k rotary carbon, lin

Capacitors

C1	2μ2 tantalum, 25V
C2	47μ radial elect., 25V

Semiconductors

D1-D3	1N4001 1A 50V rec. diode (3 off)
D5, D6	1N4148 signal diode (2 off)
D4	Standard Red l.e.d.
D7-D10	Standard Orange l.e.d. (4 off)
D11-D14	Zener diode (see text) (4 off)
TR1-TR3	ZTX300 *npn* silicon transistor (3 off)
IC1	555 CMOS timer
IC2	4011 Quad 2-input, NAND gate
IC3	4017 10-step Johnson counter
IC4	4071 Dual, 2-input OR gate
IC5	4049 Hex inverting buffer
IC6	4019 Quad, 2-input Multiplexer
IC7	4520 Dual binary counter

Switches

S1	Min. s.p.s.t. toggle
S2	Min. s.p.d.t. toggle
S3	Min. d.p.c.o. toggle
S4	Min. s.p.d.t. push-to-changeover
S5	Min. s.p.c.o. toggle (2 off)

Miscellaneous

FS1	100mA 20mm fuse and p.c.b. fuse clips
PL1, PL2	10-way "video" chassis mounting pug, with matching cable mounted socket (2 off)
SK1, SK2	7-pin DIN 180° chassis mounting socket, with matching plug (2 off)

Aluminium instrument case (Maplin "Blue Case 233", size 250mm x 150mm x 75mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (5 off); plastic knobs for VR1 and S4; self-adhesive p.c.b. stand-off pillars (4 off); connecting wire; solder pins; l.e.d. clips; nuts and bolts for sockets; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE772.

Approx cost guidance only **£30** *plus case*

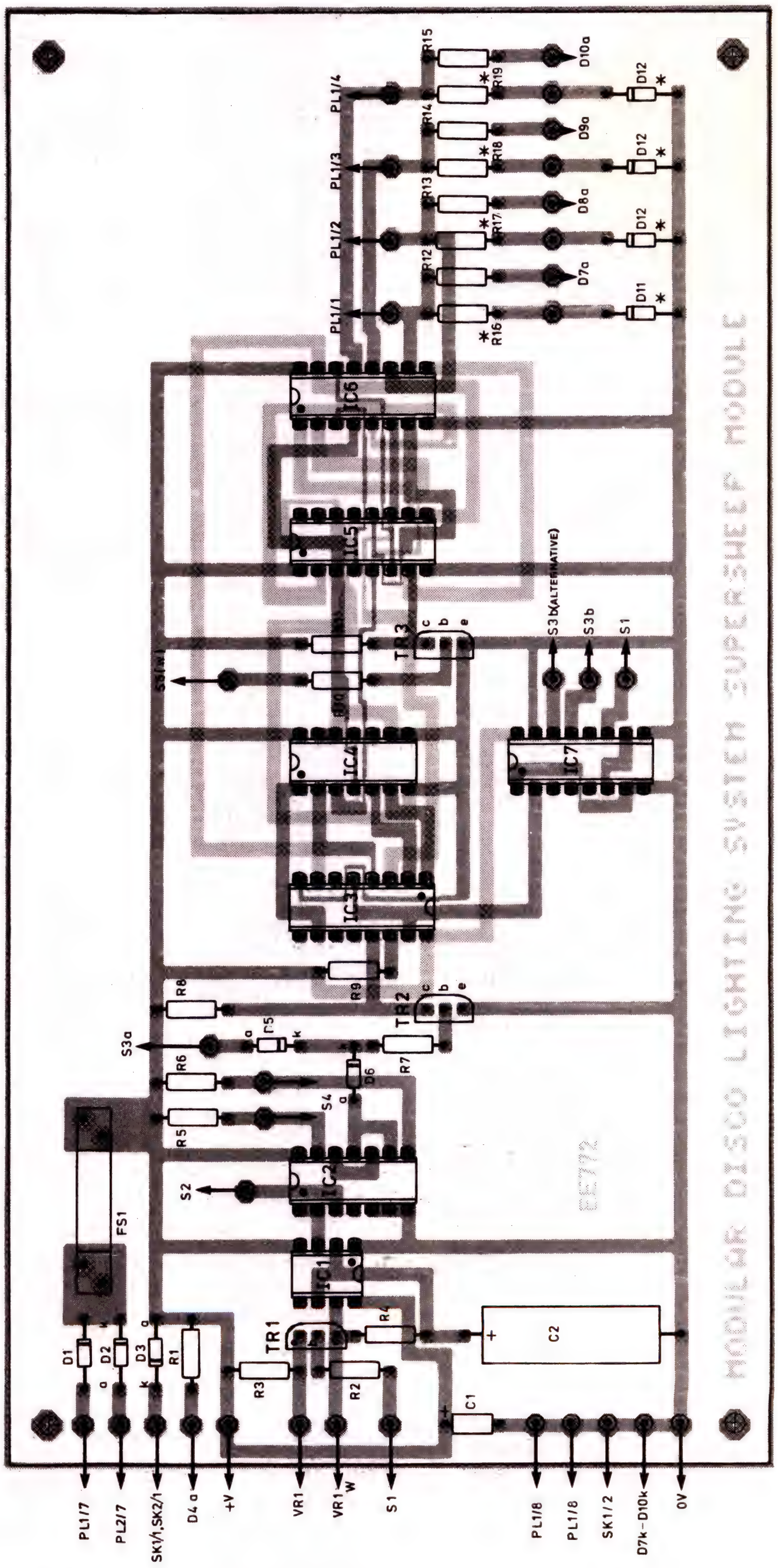


Fig. 4. Printed circuit board component layout for the Supersweep.

Modular Disco Lighting System. The Supersweep Module's output does not readily lend itself to a Pattern Reverse mode and therefore this is not included.

CONSTRUCTION

Both of these modules are built using double-sided printed circuit boards, the full size copper foil patterns for which are shown as Fig. 2. (Superchaser) and Fig. 4. (Supersweep). These should either be made by the normal process or prepared boards may be purchased from the *EE PCB service*, codes EE771 and EE772 respectively.

After the board has been prepared or obtained the components should be inserted into the correct positions as shown in the appropriate layout diagrams (Figs. 2 and 4), and soldered into place. Because of the use of double-sided p.c.b.s for these circuits it is important that where components are connected to tracks on both sides of the board both sides are soldered, since these connections are used to route signals from one side of the board to the other.

Care must be taken to ensure that polarised components such as semiconductors, i.c.s and polarised capacitors are inserted in the board the correct way round, since if these are inserted with incorrect polarity the circuit will not work and components may be damaged. Although this process can be carried out in any order you will probably find that it is easier to accomplish if the components are inserted in ascending order of size,

The integrated circuits are best carried in integrated circuit holders. Where i.c.s carry connections which are soldered to tracks on the top surface of the p.c.b. the best method of accomplishing this is to use wire wrap i.c. holder pins to be soldered to the top surface of the board.

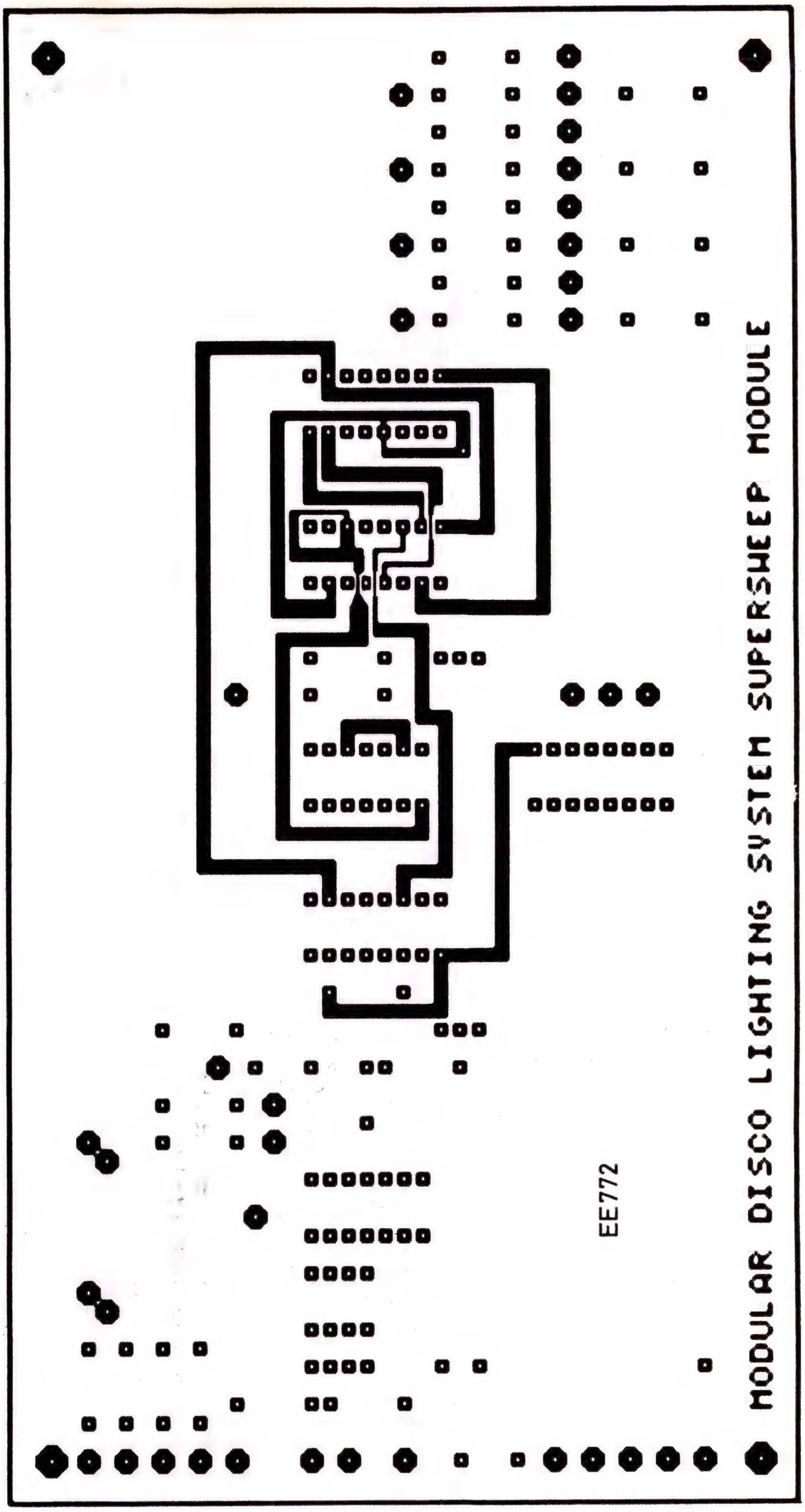
The connection of the p.c.b. to the case mounted components will be found easier by the use of connecting pins soldered to the points on the p.c.b. where wires are to be attached to route connections to the case mounted components. If the special components required for use when the module is to be used with theatre dimmer racks are to be omitted then these should be installed in the alternative positions described in the text and not as shown in the circuit diagrams.

BOARD TESTING

Once completed the boards should be carefully inspected to ensure that there are no broken tracks, solder blobs bridging tracks or components misplaced before attempting to test the circuit. This can be done before the circuit is mounted in it's case by making temporary power connections to the plus volts (+V) and zero volts (0V) terminations on the p.c.b. and directly connecting the l.e.d.s between their connecting points on the p.c.b. and a suitable 0V connection point.

The required switching points for external pulse and control signals can be mimicked by the use of a flying lead connected temporarily to +V as required. Alternatively testing can be postponed until the p.c.b. has been mounted in the module's case.

Irrespective of which strategy is adopted the testing process should be conducted to ensure that the circuits behave as described in the circuit descriptions. If the circuit should fail to operate as described then the fault should be traced using the circuit diagram and the circuit descriptions.



Supersweep full size copper foil master pattern component side.

CASE

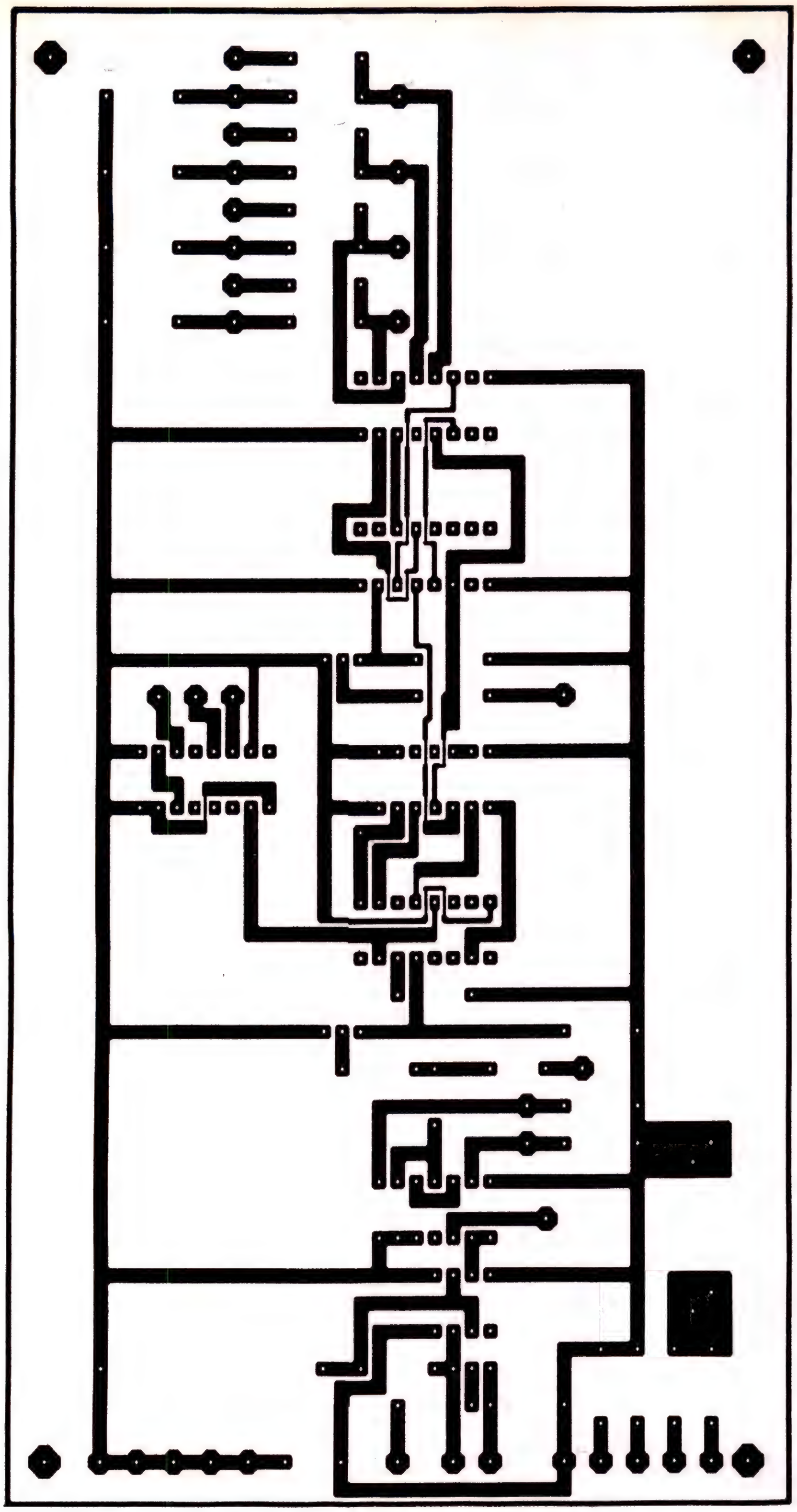
As with the other modules in this series the case layouts should follow the general principles exhibited in the other modules in this series. The p.c.b.s have been designed to fit into the case detailed in the Components List, which matches those given for the other modules in the series.

Before mounting the case mounted components the case should be drilled and lettered in the normal way. Once the case is ready the first step is to install the p.c.b. into a suitable position, using self-adhesive p.c.b. supports. The p.c.b. can then be connected to the case mounted components in accordance with the circuit diagram. This will be eased if as many different colours of wire as possible are used.

You may find that connection of the output sockets is eased if these are prewired prior to installation. The Masterlink DIN sockets SK1 and SK2 must be wired with all of the pins on one socket connected to the corresponding pins on the other socket, even if these connections are not used on the module being constructed, so as to ensure that the modules can be stacked in any order. When wiring up the p.c.b. to the case mounted components it is important to remember that it may be necessary to remove the p.c.b. from the module case in order to trace faults etc. and sufficient wire should be left to enable this to happen.

IN USE

The two modules described in this article must be connected into the rest of the system

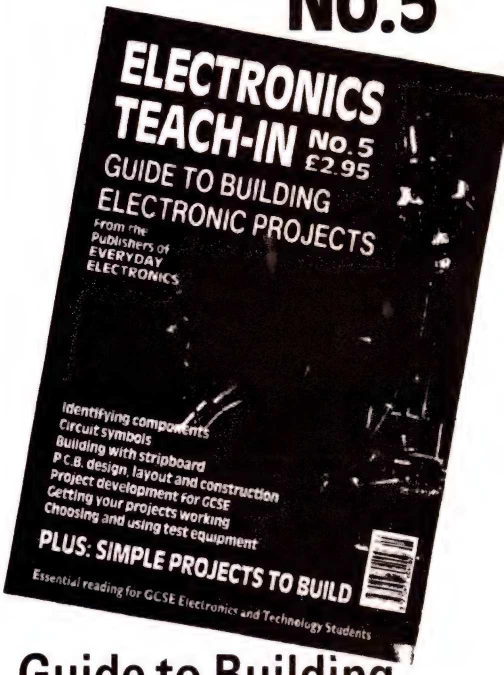


Supersweep full size copper foil master pattern component side.

in the same way as all of the other modules, by connecting them to at least one Output Module. The Masterlink DIN sockets on all of the modules in use must also be connected together if either the Masterlink or the External Pulse facilities are to be used by any module in the system. This is because of the fact that all of these signals are "bussed" through the Masterlink sockets on each module.

These two modules offer very sophisticated facilities but their method of operation is exactly as described for the other modules in the series. Once the modules have been connected together all that has to be done is to set the control and routing switches and speed controls to the desired positions. The system should then almost drive itself whilst you get on with looking after the rest of the show.

When the Masterlink switch is set to the "ON" position the entire control of the module's outputs is linked into the signals from the Masterlink Module. When this is selected for all of the modules in the system the effect is somewhat spectacular, since the sight of all of the modules, with their many different patterns all stepping at the same moment is very impressive, especially if these are synchronised to the music by switching the pulse inputs of the Masterlink module to the external pulse mode. ☐



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INTERFACE

Robert Penfold

WHEN the interface series started we promised that the "golden oldie" 8 bit computers would not be forgotten. This month we will take a break from IBM PC compatible interfacing and consider one of the most popular of the 8 bit computers, the Commodore 64. This computer dates back almost as far as the BBC model B, but I think I am right in saying that it is still available today (it is currently advertised in some of the "mega" mail order catalogues).

It is only fair to point out that there have been several versions of this computer over the years. These range from a games console through to an enhanced model with extra memory etc. The information given here is for the original version, and versions that are fully software/hardware compatible with the original Commodore 64. This probably includes most of the Commodore 64s in existence, but would obviously not include something like the games console version.

The Commodore 64 is quite a good computer from the interfacing point of view, and it really deserves rather more attention in the electronics press than it has received over the years. Interfacing to its buses is possible via the cartridge port, but is not particularly easy. On the other hand, it has a user port which is similar to that on the BBC computers, and this offers an easy means of connecting your own circuits to the computer.

One slight snag here is that some software utilizes the user port as a parallel printer port or a serial port. If you are using the port in either of these ways, then it will clearly be difficult to use it for you add-on circuits. I suppose that it should be possible to devise a switch-over box to permit switching between the printer or modem and your add-on devices.

User Port

The Commodore 64 user port is provided by port B of a 6526 CIA (complex interface adaptor). This is very similar to the standard 6522 VIA (versatile interface adaptor), as used on the BBC model B, VIC-20, etc. There are some substantial differences though, particularly with regard to the handshake lines and the counter/timers. Fig.1 gives details of the functions available on the user port.

You need a female 2 × 12 way 0.156 inch edge connector to provide the physical connections to the port. Note that this connector has a pitch of 0.156 inches, and not the more common 0.1 inch pitch type. The port has provision for two polarising keys, and some suppliers sell keys which can be fitted into the appropriate positions. If you do not use a connector with at least one of the polarising keys fitted, clearly mark the top and bottom edges of the connector as such. Fitting the connector the wrong way up could have disastrous consequences for your add-on circuit.

The usual ground (0 volt) and +5 volt supplies are available, and up to 100 milliamps can be drawn from the +5 volt supply. There is also a 9 volt a.c. supply, which can be useful if a negative supply is required. Fig.2 shows the basic method of deriving a negative supply from one of the 9 volt a.c. outputs. This will give a non-stabilised supply voltage of about −12 volts, but this can obviously be reduced to (say) −5 volts using a simple regulator circuit. A maximum current of about 50 milliamps should be drawn from the 9 volt a.c. outputs.

8 Bit Port

Lines PB0 to PB7 are an 8 bit input/output port which is very similar to that of the BBC model B computer. A data direction register enables each line to be individually set as an input or an output. The data direction register is at address 56579, while the port itself is accessed at address 56577. Using data direction registers and input/output ports is a subject that has been covered in previous articles in *Everyday Electronics*, and it is not something we will consider in detail here.

Setting a bit to 1 in the data direction sets the corresponding user port line as an output – setting it to 0 sets it as an input. For example, from BASIC the instruction POKE 56579, 240 would set PB0 to PB3 as inputs, and PB4 to PB7 as outputs. The logic AND function can be used to selectively read bits of the user port. In this example, ANDing with a mask value of 15 would read PB0 to PB3 while masking PB4 to PB7.

Handshaking is rather different to the usual 65** and 68** scheme of things, with no direct equivalents to the usual CB1 and CB2 handshake lines. The most simple of the handshake lines is PC2, which is a strobe output. This goes low for one clock cycle after each read and write operation to the user port. It is not needed to latch data from the port, since lines set as outputs are latching types.

This output can be used to indicate that fresh data is available on the outputs, or to indicate that data has been read by input lines and that fresh data is awaited. This line is a convenient one in that it provides the handshake signal automatically. However, this might render it unusable if the port is used to provide both input and output lines. Remember that read and write operations to the port both activate this output signal.

Flag 2 is a negative edge sensitive handshake input. In other words, it sets a flag in a status register when it is taken from the high state to the low state. Like most handshake inputs, its static logic level cannot be read. When Flag 2 is activated bit 4 of the interrupt control register is set to 1.

The interrupt control register is at address 56589, and bit 4 can be read using the AND function plus a masking number of 16. From BASIC the instruction PRINT PEEK(56589) AND 16 would therefore return a value of 16 if the flag is set, or 0 if it is not. To reset the flag simply perform a read or write

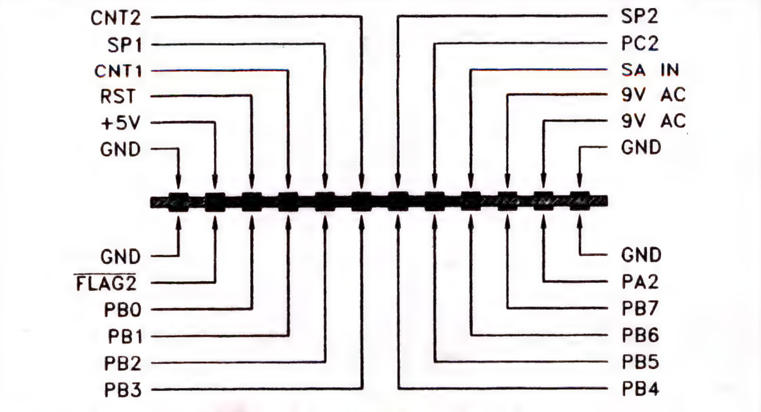

Fig. 1. The Commodore 64's user port. This has provision for two polarising keys.

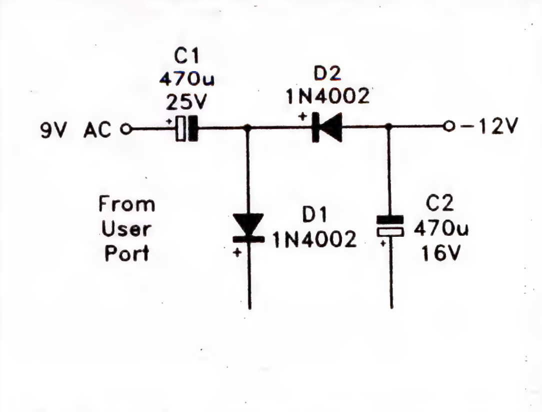

Fig. 2. Deriving a negative supply from one of the 9V a.c. outputs of the C64.

operation to the user port. On finding that the flag has been set, such an operation would normally be performed anyway.

PC2 and Flag 2 do not provide as many handshaking options as CB1 and CB2 on chips such as the 6522. In fact you are limited to what is basically one form of handshaking, but for most purposes they can provide simple but effective handshaking. If they should not "fit the bill", there is a third handshake line available, and this is PA2. The 6526 has two 8 bit ports, which are port A and port B. PA2 is simply bit 2 of port A, and is a standard input/output line, like PB0, PB1, etc. of the user port.

Port A

Port A is at address 56576, while the data direction register for this port is at address 56578. Writing a value of 4 to address 56578 will therefore set PA2 as an output, or a value of 0 will set it as an input (which it is by default anyway). Writing a value of 4 to address 56576 will set PA2 high, or writing a value of 0 to this address will set it low. Reading address 56576 with a masking number of 4 (e.g. PRINT PEEK(56576) AND 4) will return a value of 0 if PA2 is low, or 4 if it is high.

Having PA2 available obviously increases the versatility of the user port, but where possible it is better to use PC2 and (or) Flag 2 for the handshaking. These lines are specifically designed for handshaking purposes, and will generally be faster in operation and easier to use. Of course, PA2 does not have to be used for handshaking purposes. If you need an odd output line to control a relay driver or something of this nature, then PA2 should be able to handle the job.

RST is a reset output, and this pulses low at switch-on and whenever the computer is reset. Some add-on circuits require a reset pulse to ensure that they start-up with everything in the right state. In most cases RST can be used to provide this signal, and it will avoid the need to include a reset generator in the add-on circuit. Note that RST can be pulled low by an open collector output or mechanical switch in order to produce a "cold-start" from the computer.

Counting On It

Like the 6522, the 6526 has two 16 bit timer/counters. These are "down" counters. In other words, you write a value to the latches, load it into the counters, and they then count down from this value to zero. The counters are 16 bit types, but they must be loaded and read using two 8 bit bytes.

Although these are similar to the 6522 timer counters, they are not direct equivalents. For each timer there are two read/write registers, which are the usual high and low byte pairs. The write registers are used to latch control data into the timers, while the read registers are used to read the current values. The mode of each timer is governed by a control register. These are the addresses of the six registers associated with the timer/counters.

REGISTER	ADDRESS
Timer A Low Byte	56580
Timer A High Byte	56581
Timer B Low Byte	56582
Timer B High Byte	56583
Control Register A	56590
Control Register B	56591

If we consider control register A first, this is a list of the functions performed by the bits associated with timer/counter A:

Bit 0 – Set to 0 in order to halt timer A, or 1 in order to start it.

Bit 1 – Set to 0 to provide normal operation, or set to 1 to enable output on PB6.

Bit 2 – This controls the output mode. When set to 0 timer A provides brief (about 1µs) positive pulses. When set to 1 the output is a squarewave with each half cycle equal to one count-down in duration.

Bit 3 – This bit controls the running mode. It is set to 1 for one-shot operation, or 0 for continuous operation. In other words, when it is set to 1 the timer does one down count and then stops. When set to 0 the counter is reloaded each time the count reaches zero, and a fresh count down is commenced.

Bit 4 – It is only valid to write a 1 to this bit. Doing so results in the value in the timer latches being loaded into the actual counters. This will happen whether or not the timer is running.

Bit 5 – This selects the source of input pulses for the timer. This is the system clock signal with bit 5 set to 0, and the input signal on CNT1 of the user port if it is set to 1.

Bits 0 to 4 of control register B operate in much the same way, but for timer B. The only difference is that the output from timer B is on PB7, not PB6. The input mode of timer B is controlled by bits 5 and 6, and this operates in the following manner:

Bit 6	Bit 5	Mode
0	0	Counts system clock pulses
0	1	Counts positive transitions on CNT1
1	0	Counts completed runs of timer A
1	1	Counts completed runs of timer A, but only while CNT1 is held in the high state

These timer counters seem to be at least as versatile as those of the 6522, and they can be used to generate low clock frequencies, act as pulse counters, etc. The Commodore 64 user port is very versatile indeed, and I would guess that any of the many projects for the BBC model B that utilize this port could easily be adapted for operation with the Commodore 64.

In the past I have certainly had no real difficult in producing projects that could be used with either computer. The only real difficulty is that BBC BASIC and the Commodore 64 version of BASIC are very different. Any software for a BBC add-on would need to be totally rewritten in order to run properly on the Commodore 64.

For do-it-yourself interfacing the Commodore 64 remains one of the best computers available. A good secondhand Commodore 64 system probably represents the cheapest way of getting into serous computer interfacing.

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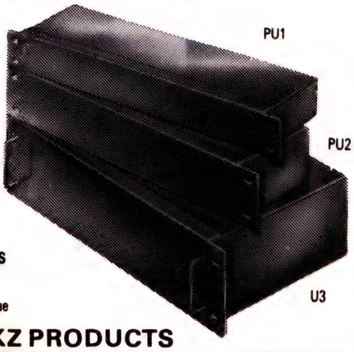

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Constructional Project

REMOTE CAMERA RELEASE

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When taking a group, the photographer would often like to be in the picture too. For this purpose, many cameras have a self-timer. The camera is arranged on a tripod or other firm support, the button pressed and the operator gets into position. After a short delay, the shutter clicks and the picture is taken.

The problem is that the photographer loses control the moment the self-timer is actuated. This often leads to poor results since no one knows exactly when the picture will be taken and expressions tend to take on a strained look. Where unpredictable subjects such as children or pets appear in the picture, the problem is made much worse.

The Remote Camera Release solves the problem by allowing the photographer to operate the shutter at the best moment. This is done by pressing a button on a small handheld unit which works in conjunction with a camera-based main section.

Although intended for photographic use, the basic circuit is very versatile and some readers will use it for other short-distance low voltage remote control applications. The prototype has a range of between 10 and 15 metres (33ft to 50ft approximately) and this will be found sufficient for most purposes.

The handheld unit is small and will not be noticed in the "subject" photograph. Note, however, that it is necessary for it to have a clear "*line of sight*" to the sensor at the camera end.

The Remote Camera Release may be used with any camera so long as it is fitted with a standard cable release socket. Although the mechanical — that is, the non-electronic work is not too difficult, the constructor will need access to a set of small taps and dies and be reasonably proficient at metalwork.

OPERATING PRINCIPLE

The circuit operates on the *ultrasonic* principle. On pressing a button on the handheld transmitter unit, a signal is produced by a 40kHz transducer. This is a sound wave but of a much higher frequency than the ear can hear (humans can hear up to 18kHz approximately).

The sound is detected and turned into an electrical signal by a matching 40kHz receiver sensor, which is plugged into the camera-based unit. This signal is amplified and used to operate a miniature motorized gearbox.

A cam attached to the gearbox output shaft then actuates a cable release and hence the camera shutter. The force provided by the cable release has been found adequate for all cameras tested.

The relatively simple nature of the circuit means that there is a chance of false triggering. Sounds such as breaking glass, sharp whistles and loud hand claps may sometimes operate the unit. However, in view of the short time which elapses between switching on and taking the photograph this is unlikely to be a problem.

Once the photograph has been taken, the unit becomes insensitive to further action and must be reset using a push-button switch before being used again. This avoids possible damage if the unit were to operate a second time without winding on the film. A red l.e.d. indicator signals this "locked out" condition.

The receiver section consists of two parts. The first is the sensor unit which contains an ultrasonic receiver transducer, circuit panel, battery, on-off switch, reset switch and l.e.d. indicator.

The second part is the actuator unit and contains the motor/gearbox, cam and cable release assembly. It also houses a 4.5V battery pack to operate the motor. The sensor is connected to the actuator unit through a short flying lead and a jack plug and socket.

The handheld transmitter unit contains an ultrasonic transmitter, circuit panel, battery and pushbutton switch. The battery is a special miniature 15V type. If a larger box is used then a 9V PP3 battery could be used without further modification.

CIRCUIT DESCRIPTION

The circuits for the Remote Camera Release are shown in Fig. 1 (transmitter) and Fig. 2 (receiver). The transmitter circuit centres on IC1, a 555 timer i.c. which is configured as an astable multivibrator.

With switch S1 (Shutter) pressed, a supply is established from the 15V battery, B1. IC1 output, pin 3, then delivers a signal whose frequency depends on the values of fixed resistor, R1, preset, VR1 and capacitor, C2. With the values specified, this will lie between 30kHz and 50kHz approximately depending on VR1 adjustment.

The output from IC1, pin 3, is directly coupled to the ultrasonic transmitter transducer, X1, which then emits the high-frequency tone. Preset VR1 is adjusted at the setting-up stage so that the output frequency matches the resonant frequency of X1 (nominally 40kHz). The "loudest" signal is then emitted and the maximum operating range obtained.

With switch S1 off, no current is drawn from the battery. While pressed, the unit draws 10mA approximately.

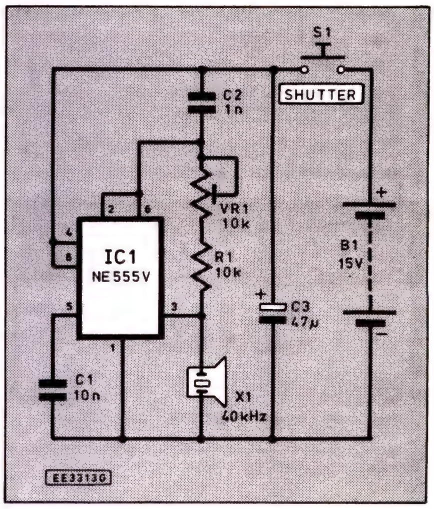


Fig. 1. Circuit diagram for the handheld transmitter.

RECEIVER

Turning to the Receiver circuit diagram Fig. 2. With switch S3 (On/Off) switched on, a supply is established from the 9V battery, B2, to the control circuit. When the receiver transducer X2 detects the wave emitted by X1 in the transmitter, it converts it into a low-level a.c. signal. This signal is applied to transistor, TR1 base through capactior, C4 and an amplified signal appears at the collector. Resistor R2 provides base bias.

A dual 7556 CMOS integrated circuit IC2 contains two identical timer sections, IC2a and IC2b. IC2a is connected as a monostable. Thus, when triggered by making pin 6 low (less than 1/3 supply voltage) for an instant, the output, pin 5, goes high for a short time then reverts to low. The time during which it remains high depends on the values of resistor R7, preset VR3 and capacitor C7 and with those specified will lie between 0.2 and 2 seconds approximately.

The collector of TR1 is coupled via capacitor C5 to IC2a trigger input, pin 6. Resistor R4, preset VR2, and resistor R5 form a potential divider which applies a steady voltage to pin 6 and with VR2 correctly adjusted, this voltage just exceeds the triggering voltage — that is, IC2a remains off.

When the received signal appears at TR1 collector it has the effect of modulating the voltage already existing at pin 6 — the voltage rising and falling about the steady value. On the first occasion when it falls, IC2a is triggered and the output, pin 5, goes high (positive supply voltage).

This high state is applied, via resistor R8, to the base of transistor TR2 which turns on. Collector current then flows through the coil of relay RLA and energizes it.

The changeover contacts of the relay switch over, with the common one moving from the normally-closed (n.c.) to the normally-open (n.o.) position. Motor M1 turns with current flowing from battery B3 through RLA normally-open contacts and microswitch S4 normally-open contacts.

DYNAMIC BRAKING

Attached to the motor/gearbox output shaft is a cam and, in the rest position, its lobe presses against S4 microswitch actuating lever, keeping the normally-closed contacts open and the normally-open ones closed. When the motor begins to turn, the actuating arm is released and the contacts change over — that is, the normally-closed ones now close and the normally-open ones open. The motor now receives current direct through S4 normally-closed contacts.

Meanwhile, the monostable switches off and the relay is de-energized. Its contacts then move back to their normally-closed position. The cam, however, continues to turn for the rest of the duty cycle and actuates the camera shutter.

Soon after this, the lobe of the cam presses the microswitch arm once again and the normally-open contacts "make". This applies a short circuit to the motor armature winding via RLA normally-closed contacts. This has the effect of stopping the motor instantly and not allowing it to overrun as would be the tendency otherwise.

This is called "dynamic braking" and is used in such things as car windscreen wipers. If the motor overran, there would be the possibility of S4 normally-closed contacts "making" again so allowing the motor to turn indefinitely.

The use of a relay and separate batteries for control and motor prevents problems with false triggering. Diode D2 bypasses the high-voltage "spike" formed as the magnetic field in the relay coil collapses.

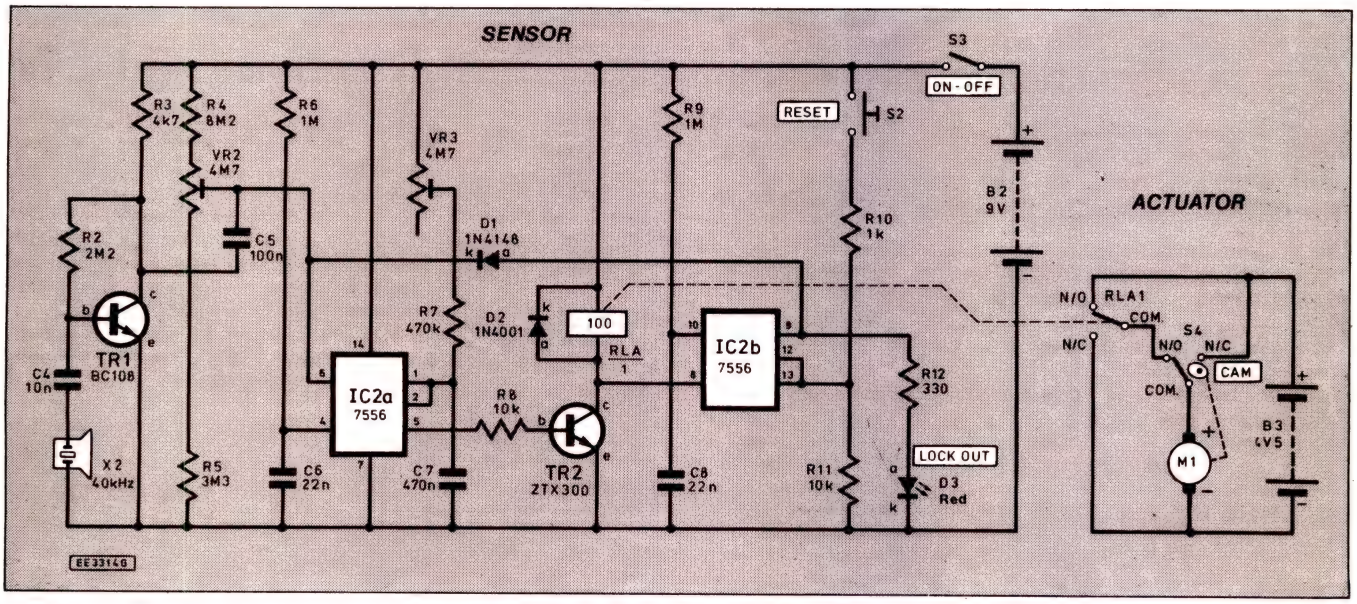


Fig. 2. Circuit diagram for the Receiver and motor-driven camera shutter trigger lead.

COMPONENTS

TRANSMITTER

Resistor

R1	10k 0.25W 5% carbon film

Potentiometer

VR1	10k Sub-min. vertical preset, lin.

Capacitors

C1	10n ceramic
C2	1n ceramic
C3	47µ p.c.b. elect., 16V

Semicondctor

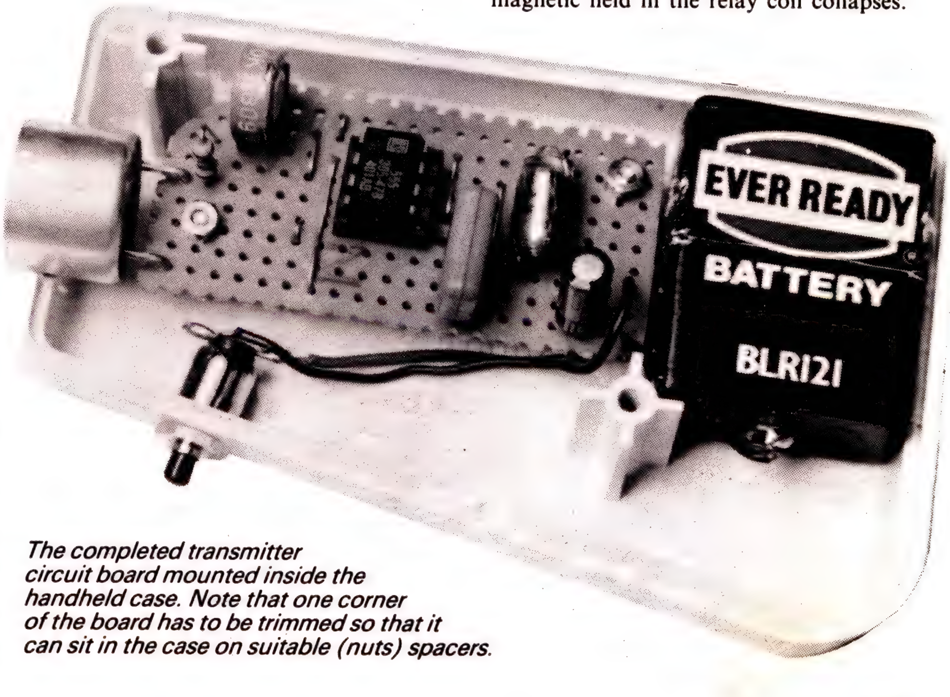
IC1	NE555V timer

Miscellaneous

X1	40kHz ultrasonic transmitter (matched to receiver X2)
S1	Sub-miniature push-to-make switch
B1	15V BLR121 type battery

Stripboard 0.1in. matrix, size 9 strips x 20 holes; 8-pin i.c. socket; small handheld plastic box (Verobox 401); connecting wire; stranded wire; small fixings; solder etc.

Approx cost guidance only **£7** *excl. Batt.*



The completed transmitter circuit board mounted inside the handheld case. Note that one corner of the board has to be trimmed so that it can sit in the case on suitable (nuts) spacers.

This could otherwise damage semiconductor components. Capacitor C6, in conjunction with fixed resistor R6, keeps IC2a reset input (pin 4) low for an instant after switching on and this prevents self-triggering.

TIMING

The time period of the monostable is not critical. It must be long enough to allow the cam lobe to release the microswitch lever but be less than the time taken for one rotation of the output shaft.

The gearbox increases the torque of the motor and reduces the speed to a manageable rate — approximately one revolution in three seconds. At this speed, the shutter will operate one second approximately after the button on the handheld transmitter unit has been pressed.

LOCK-UP

When IC2a output, pin 5, is high the collector of transistor TR2 is low and this state triggers IC2b at pin 8. IC2b is configured as a set-reset bistable.

Once triggered IC2b output, pin 9, goes high. However, unlike IC2a, it will remain high indefinitely since the threshold and discharge pins are kept low through fixed resistor, R11.

The high state of pin 9 is applied through diode D1 to the trigger input of IC2a (pin 6) so causing it to lock-up and be insensitive to receiving further trigger pulses. The l.e.d. D3 signals the locked-up state with current flowing from pin 9 through current-limiting resistor, R12. Resetting is achieved by making IC2b pins 12 and 13 high for an instant by using pushbutton Reset switch S2.

CONSTRUCTION

The transmitter unit uses a circuit panel made from a piece of 0.1in. matrix stripboard, size 9 strips x 20 holes. The topside component layout and details of breaks required in the underside copper tracks is shown in Fig. 3. If using the specified box it will be necessary to file off one corner of the panel to clear the lid securing bush.

Drill the two mounting holes and make all copper track breaks and inter-strip links. Mount the on-board components as shown observing polarity of capacitor C3.

When bending the leads to mount transducer X1, great care must be taken to avoid damage. Use two pairs of pliers, one to grip a lead near the body of the device and the other to make a right-angle bend approximately 4mm long.

Solder 10cm pieces of light-duty stranded connecting wire to strips *G* and *I* on the right-hand edge of the circuit panel. Adjust preset VR1 to approximately mid-track position and insert IC1 into the socket with the correct orientation.

Prepare the handheld case by drilling holes for the ultrasonic transducer X1, switch S1 (Shutter) and for the circuit panel mounting. Referring to Fig. 4, mount switch S1, complete the wiring and attach the circuit panel on short stand-off insulators.

When correctly mounted, X1 should protrude slightly through the hole in the case (see photograph). Switch S1 connections should be bent away from the circuit panel so that they cannot touch the copper strips.

Solder the connecting wires to the battery B1 quickly to avoid melting the plastic. Alternatively, hold them in position using a small elastic band. Secure the battery to the base of the box using an adhesive fixing pad. Check that the lid fits but do not secure it yet.

RECEIVER

Construction of the Receiver is split into two sections, Sensor and Actuator, and requires two boxes. The actuator, built in a metal case, houses the motor/gearbox, cam assembly and also the motor power supply B3.

The Sensor is built in a plastic case and houses the control circuit and battery B2. This box also carries the "locked out" l.e.d. indicator, D3, reset switch S2 and on-off switch, S3. A flying lead with a jack plug on the end connects the sensor to a matching socket on the actuator.

The specified motor/gearbox unit is bought as a kit and is type 431G made by Como Drills. A cable release will need to be bought too since this becomes part of whole assembly.

The circuit board for the Receiver is made from a piece of 0.1in. matrix stripboard, size 14 strips x 27 holes. Fig. 5 shows full top and underside details.

Cut the panel to size, drill the mounting holes and make all inter-strip links and track breaks. Note that the links must be made before the on-board components are added.

Solder the components into position taking care over the orientation of diodes, D1 and D2. Note that D2 is soldered directly on the relay RLA coil connections on the underside — that is, the copper strip side of the panel.

The relay pin spacing does not match the 0.1in. matrix exactly but slight bending of the pins allows a good fit. The moving contact connection is not soldered to the circuit panel but is bent away from it and a direct connection made. Solder 10cm. pieces of light-duty stranded connecting wire to strip *I* on the left-hand side and to strips *A*, C and *F* on the right-hand side.

SENSOR CASE

Prepare the Sensor plastic case to receive the circuit panel by drilling holes and mounting switches S2, S3 and l.e.d. indicator D3. Drill holes also for circuit panel mounting and for the relay flying lead to pass through.

Make up this lead using a piece of light-duty 3-core wire 30cm (1ft) long. Connect it up and tie a piece of string tightly inside the box to provide strain relief. Pass it through the hole drilled for the purpose and fit the 3.5mm stereo-type jack plug on the free end.

Refer to Fig. 6 and complete the wiring, shortening any wires as necessary. Mount the circuit panel on short stand-off insulators. Insert IC2 into its socket without touching the pins. This is because it is a

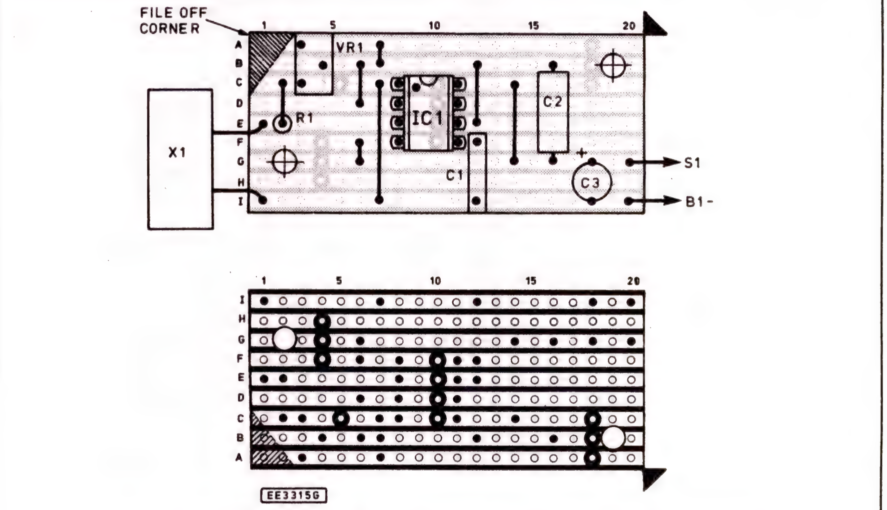
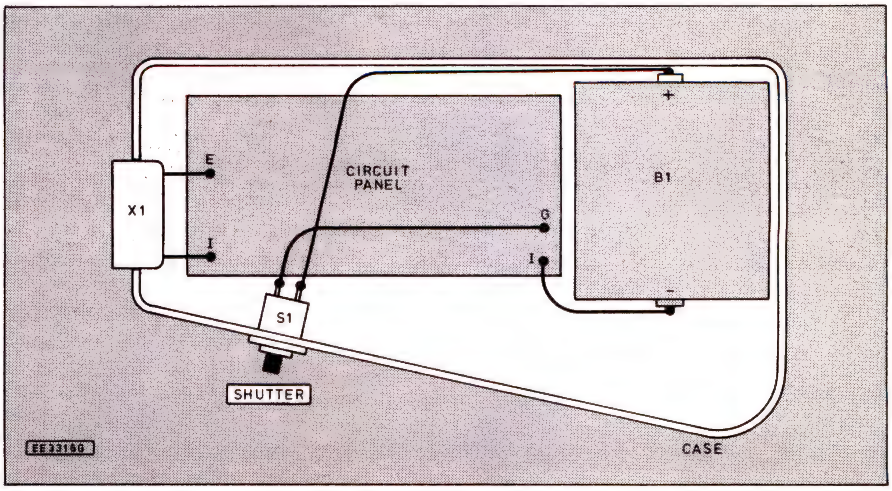


Fig. 3. Transmitter stripboard component layout and details of breaks required in the underside copper tracks.

Fig. 4. Interwiring from the transmitter board to the transducer, switch and battery.



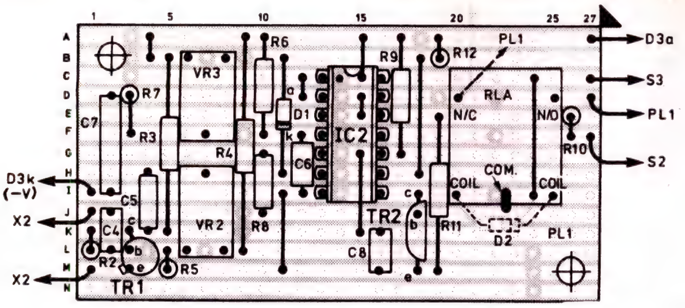
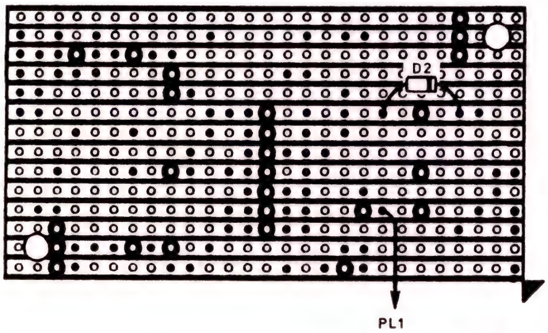
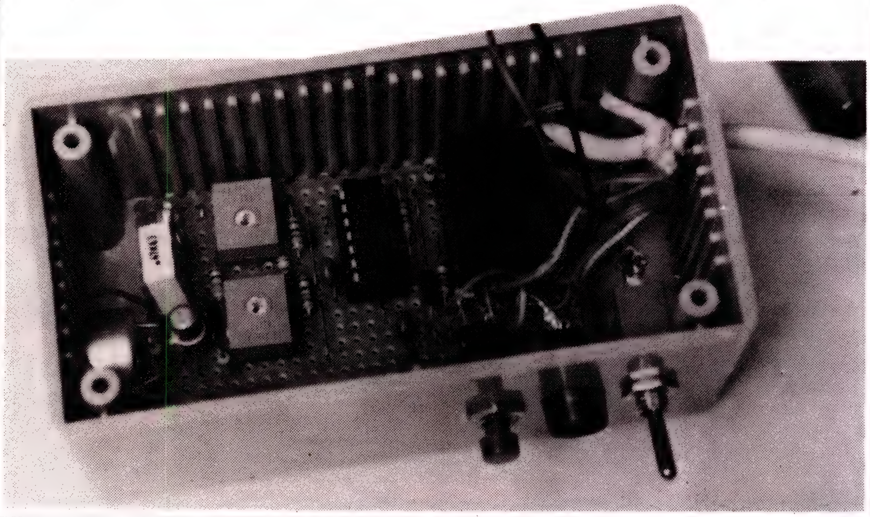


Fig. 5. Receiver stripboard component layout and details of breaks required in the underside copper tracks.





The complete sensor board installed in its case. Note the "string" cable strain relief for the relay lead.

COMPONENTS

RECEIVER

Resistor

R2	2M2	R6, R9	1M (2 off)
R3	4k7	R7	470k
R4	8M2	R8, R11	10k (2 off)
R5	3M3	R10	1k
		R12	330

All 0.25W 5% carbon film

Potentiometer

VR2, VR3 4M7 Sub-min horiz. lin.

Capacitors

C4	10n
C5	100n
C6, C8	22n (2 off)
C7	470n

Semiconductor

D1	1N4148 signal diode
D2	1N4001 1A 50V rec. diode
D3	Standard red l.e.d.
TR1	BC108 *npn* silicon transistor
TR2	ZTX300 *npn* silicon transistor
IC2	7556 dual CMOS timer

Switches

S2	Min. push-to-make switch
S3	Miniature s.p.s.t. slide or toggle switch
S4	Sub-miniature s.p.d.t. microswitch, with lever-arm and roller

Miscellaneous

B2	9V PP3 battery
B3	3 off AA size alkaline cells, holder and connector
M1	Motorized gearbox (see text)
X2	40kHz ultrasonic receiver (matched to transmitter X1)
PL1/SK1	3.5mm stereo-type jack plug and chassis socket
RLA	6V 100 ohm coil relay, with 5A changeover contacts

Stripboard 0.1in. matrix, size 14 strips x 27 holes; 14-pin i.c. socket; plastic box, size 54.5mm x 104.5mm x 42mm (for Sensor); aluminium box, size 102mm x 102mm x 64mm (for Actuator); stranded wire; connecting wire; small fixings; solder etc.

Approx cost guidance only **£20** *excl. Batts.*

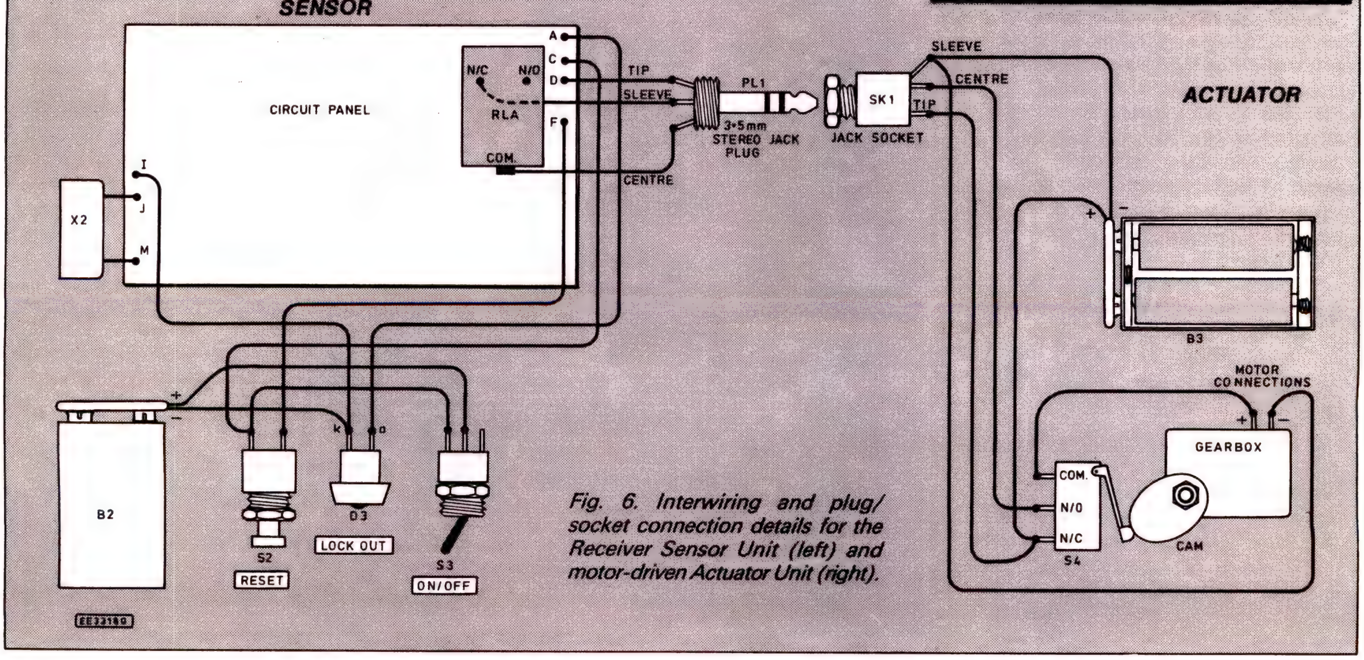
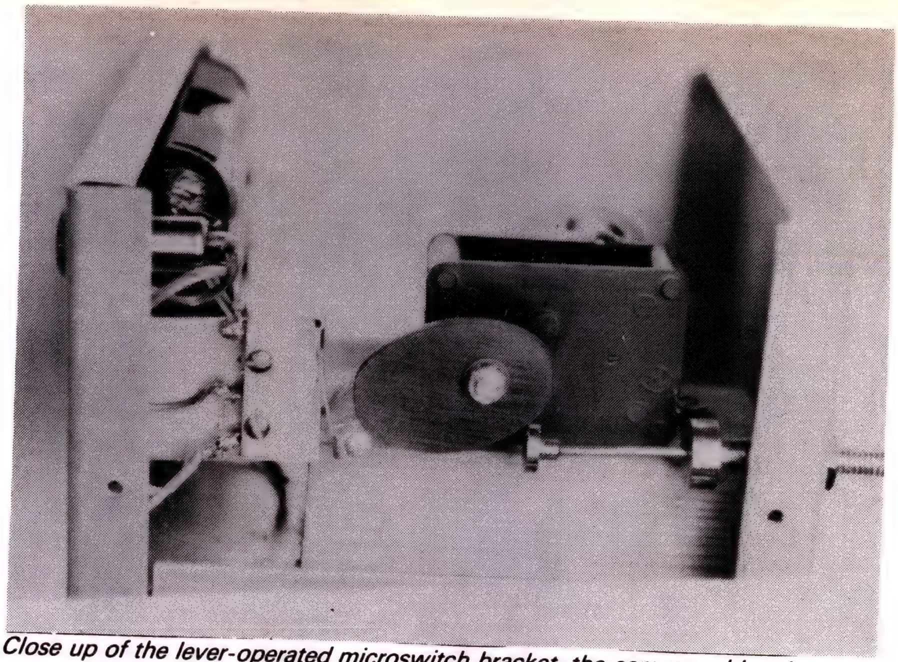


Fig. 6. Interwiring and plug/socket connection details for the Receiver Sensor Unit (left) and motor-driven Actuator Unit (right).

CMOS device and could be damage by any static charge which might exist on the body.

Adjust preset VR2 fully clockwise and VR3 to approximately mid-track position. Switch off S3 and connect the battery. Secure this to the side of the case using a small bracket or adhesive fixing pads.



Close up of the lever-operated microswitch bracket, the camera cable release and motor-driven cam.

MOTOR AND GEARBOX

Make up the motor/gearbox assembly using five gearwheels, full instructions for fitting these are given on the pack. Fit the 3mm diameter output shaft temporarily and mark the long end 15mm from the plastic casing. Remove it again and cut it at the marked position.

Now, using a size 6B.A. die, cut a thread on the end 10mm of the shaft. This threaded section will be used to secure the cam later. If a die set is not owned, a local garage, engineering workshop or school should be able to oblige.

With this done, the output shaft may be replaced and the lid of the gearbox secured using a little glue. Oil the gearwheels and bearing very lightly.

Using a piece of scrap film in the camera, measure the travel of the cable release from its rest position to the point where the shutter operates. Referring to Fig. 7, cut out the cam from a piece of rigid plastic 3mm thick.

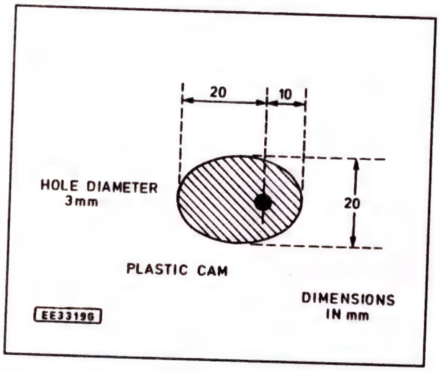


Fig. 7. Profile and measurements for the cam.

The travel provided by the cam should be slightly greater than that actually needed to operate the shutter. The profile illustrated in Fig. 7 provides a travel of 10mm approximately but should be adjusted to suit the camera being used.

Smooth and polish the cam operating surface carefully. Drill a hole 3mm in diameter in the position shown in Fig. 7. Attach the cam to the gearbox output shaft using a nut and plain washer on the inside surface and a nut, washer and star washer on the outside. Put a trace of Vaseline on the operating surface of the cam.

CABLE RELEASE

Refer to the photographs and mount the cable release. Drill a hole in the case and thread the shank using a suitable size die. Attach it using a nut on each side as shown. It may be possible to attach the cable release in others ways but it must be secure.

Refer to the photographs and mount the motor/gearbox assembly on a wooden platform so that it is high enough for the cam to clear the base of the case as it turns, and also to operate the head of the cable release correctly. A piece of wood 20mm thick was used as a platform in the prototype unit. Drill the hole for SK1 and mount it.

Connect a 4.5V battery direct to the motor and check that the cam operates the cable release smoothly. The polarity of the motor should be such that the cam rotates anticlockwise — the securing nut thus tends to tighten on the shaft as it rotates. When this point has been checked, mark the positive terminal of the motor.

Adjust the travel as necessary by moving the cable release end slightly nearer or further from the cam. With scrap film in the camera again, check that the shutter is operated when the motor is connected to the supply. Switch off promptly to prevent the cable release being operated a second time with possible damage.

Cut out and mount the small aluminium bracket shown in Fig. 8 and mount the microswitch S4 on it. Connect 10cm pieces of stranded connecting wire to the microswitch terminals. Check that these connections remain clear of the metalwork and provide some insulation if necessary.

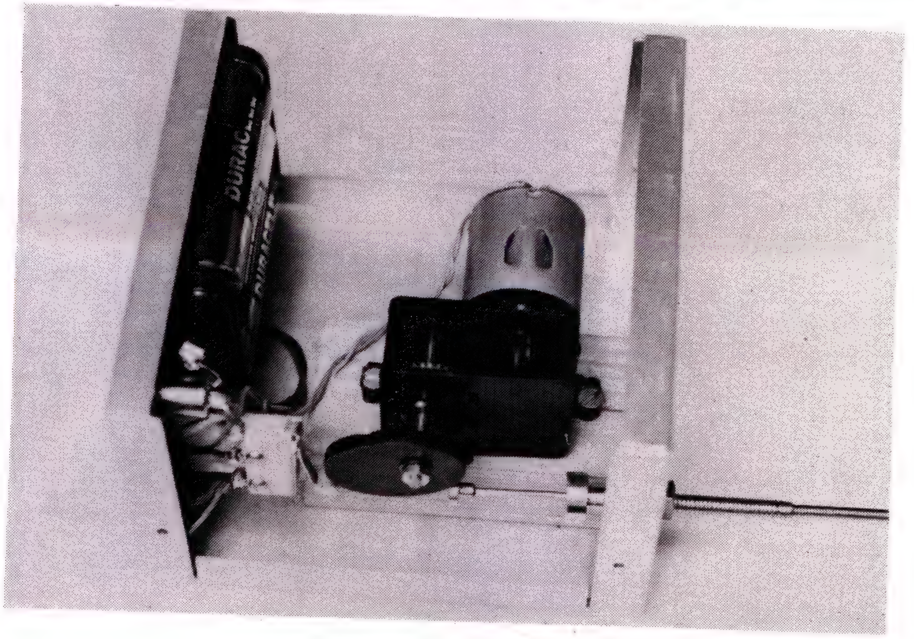
Connect the battery direct to the motor once again and check that the microswitch is operated smoothly and that it is heard to click when the lobe of the cam passes. Note that the specified microswitch is fitted with a small plastic roller and this helps greatly in giving a smooth action. It does not matter at this stage that the motor overruns.

Refer to Fig. 6 and complete the internal wiring. Take particular care to connect socket SK1 correctly to correspond with plug PL1 wiring. Mount the battery holder (see photograph).

SETTING UP AND TESTING

For initial adjustments do not plug the Sensor Unit into the Actuator Unit. Take the Sensor Unit, switch on S3 and turn preset VR2 sliding contact slowly anticlockwise. There should be a point where the monostable triggers, the relay is heard to click and the l.e.d. lights.

Layout of components inside the actuator unit. The battery pack is bolted to one of the case side panels.



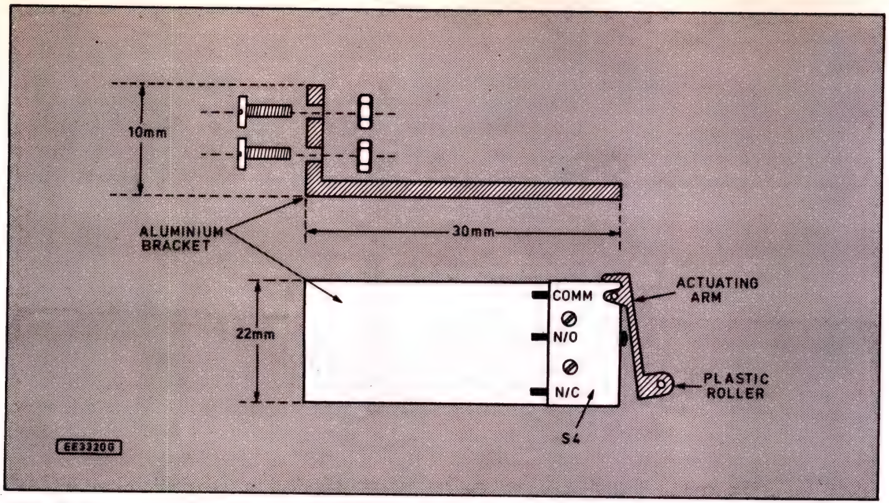
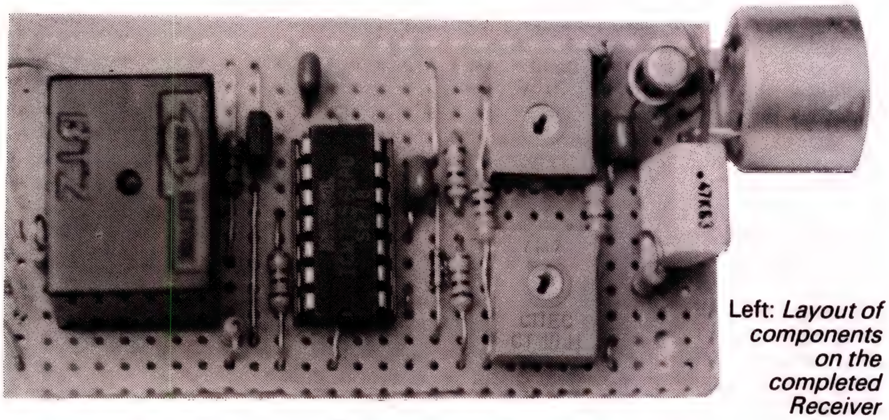


Fig. 8. Measurements and details of the small aluminium bracket for mounting the lever-operated microswitch.



Left: *Layout of components on the completed Receiver board.*

Re-adjust VR2 slightly clockwise again and reset using S2. When VR2 is correctly adjusted, there should be no tendency for the unit to self-trigger.

Now, holding the Transmitter Unit approximately 2m (6ft) away from the Sensor and with the ultrasonic transducers X1 and X2 facing each other, press switch S1 (Shutter). The unit should operate — the relay should click and the l.e.d. light. A weak audible tone is sometimes heard from the transmitter — this is not the ultrasound itself and may be ignored. Carefully adjust VR1 in the transmitter until the greatest range is obtained.

The Sensor preset VR2 may be adjusted more critically but do not carry this too far in an attempt to obtain greatest sensitivity or trouble will be experienced with self-triggering. Adjust VR3 as necessary to alter the monostable period — anticlockwise rotation of the sliding contact will increase it and vice-versa.

Place the AA cells in the battery holder of the Actuator Unit and plug in the Sensor. Note that in operation, the Sensor and Actuator Units must be placed at least 30cm (1ft) apart or there may be interference between the two which could cause false triggering.

Fit the camera with a piece of scrap film, attach the cable release and check that the shutter operates smoothly in response to a signal from the transmitter. Make any final adjustments to presets VR1 and VR2.

Attach thin straps to the two boxes of the Receiver units or other means of hanging them from the camera tripod. It now only remains to label the switches and put the Remote Camera Release into service. Happy shooting! □

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ROBOT ROUNDUP

Nigel Clark

The UK is falling further behind in the use it makes of robots. In 1990 a total of 510 robots were installed, according to the British Robot Association's annual review, an increase of 11 per cent over the year. That followed a 19.5 per cent rise in 1989.

The 1989 increase compared with 55 per cent in the US and 26.5 per cent in the Federal Republic of Germany. Even France managed to do better with a 24.8 percent improvement, matching Japan's figure. The French moved further ahead in 1990 with another 1,488 installations, a rise of 21 per cent.

The BRA's definition of a robot is a reprogrammable device designed both to manipulate and transport parts, tools or specialised manufacturing implements through variable programmed motions for the performance of specific manufacturing tasks. That does not include many of the items usually covered in this column, but the figures still give a good indication of the increasing use of robots throughout the country.

From the breakdown of prices of installations in 1990 the BTA has calculated that the total value of new robot systems during the year was £18.5m. Assuming this represented a third of the cost of installation this gave a total investment of £55m, or a little less than 6 per cent of the total investment in plant and equipment in the UK during the year.

BIGGEST USER

Japan remains by far the biggest user of robots with more installations than the rest of the world put together. In the league table of installations the UK comes sixth just behind France and a little further behind Italy, but less than a third of the West German figure and a fifth of the US.

However the UK had double the number of the next most important user, Sweden.

We get most of our robots from Japan, with home-grown supplies being the next most important source. Only five came from the States.

Reflecting the increasing costs of robots the biggest category by value was the £30,000 to £50,000 range, followed closely by those costing more than £50,000. Robots costing less than £30,000 accounted for less than one third of all installations in 1990.

USE

The most popular use for the machines remains injection moulding even though it failed to add to the total number of 1,212 in use at the end of 1989. That allowed spot welding, which recorded the most installations during the year, and arc welding which came second, to improve their overall positions at two, with 1,167, and three, with 797, respectively.

Education and research had a quiet year with only eight new robots acquired, putting it tenth out of 14 applications. However it maintained its sixth position in the all-time lists having a total of 347.

The automotive industry was again by far the biggest user of new robots, its 291 being more than half the total installed in 1990. That further consolidated its lead overall with a total of 2,232. The next nearest industry was rubber and plastics with 1,214.

The BRA's figures reveal that the UK's robot usage is not typical but there again there is no typical usage. In Japan the electronics industry is the major user followed by automotive while in the USSR electrical equipment accounts for 45 per cent of usage with automotive at the surprisingly low level of 6.5 per cent.

In Sweden the major use is in the machine industry with transport equipment a close second. France is probably the country whose usage is closest to our own with the automotive industry accounting for 42.5 per cent of robots with spot and arc welding being the most popular uses.

REGIONS

In the regional analysis of where in the UK robot usage is increasing the north west of England emphasised its dominance increasing its share from 25 per cent to 31.6 per cent during 1990. Its nearest rival last year, the north east of England slipped badly during the year from 23 per cent to 13.5 per cent and into third place behind the West Midlands which improved from 11.8 per cent to 15.3 per cent.
share slightly except for the south west

Most other regions increased their of England and a large decline in Scotland from 5.6 per cent to 1.8 per cent.

DEMISE AND CHANGE

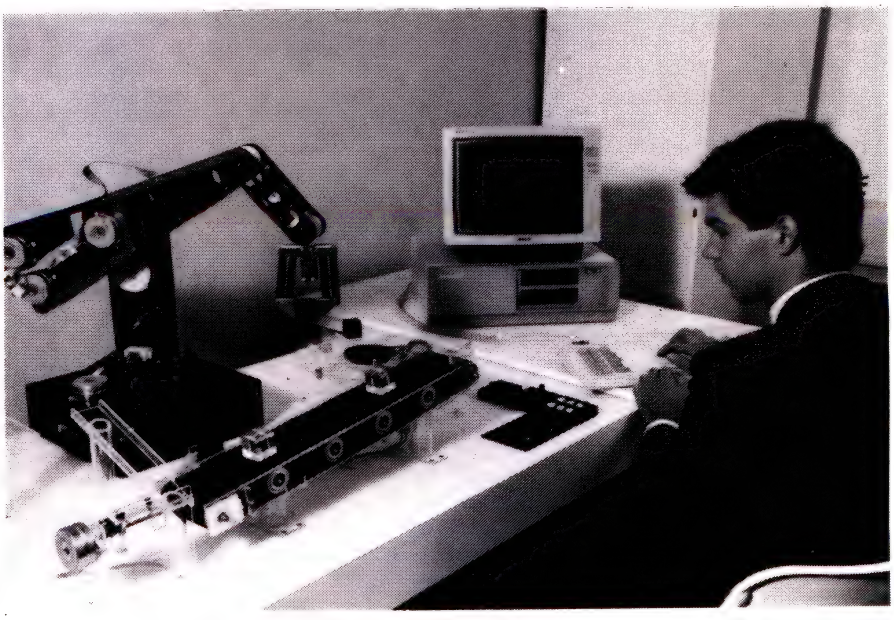
Recent months have seen the demise of a number of the early "educational" robots in the UK market, with a combination of upgrading and the economic recession to blame. Unless yet another company decides to attempt a further resuscitation the Armroid is now no longer available along with the Genesis and the Cyber 310.

Hasfield Systems, which was the latest company to produce the 5-axis Armroid, following the closure of its original maker (Colne Robotics), has decided to concentrate on its upgraded version the Bidroid. The latest machine has the same basic design as the original but with bipoplar motors giving greater speed and accuracy.

The Genesis and Cyber decisions were both the result of falling sales. They were both also under their second owners, Genesis being taken over when Feedback bought Powertran, and the sale of Cyber being taken over by Computervoice when Cyber Robotics stopped selling it.

Genesis had been under threat for some time. Known in later years as the HRA 934, one version of it had been discontinued and it was eventually only available on special order. Production was finally ended when Feedback decided to pull out of robots, also ending production of the IVAX901, another Powertran machine, and its own-developed PW801. The decision followed a running down of the robot side which began two years ago when the range was cut to three.

The Cyber 310.



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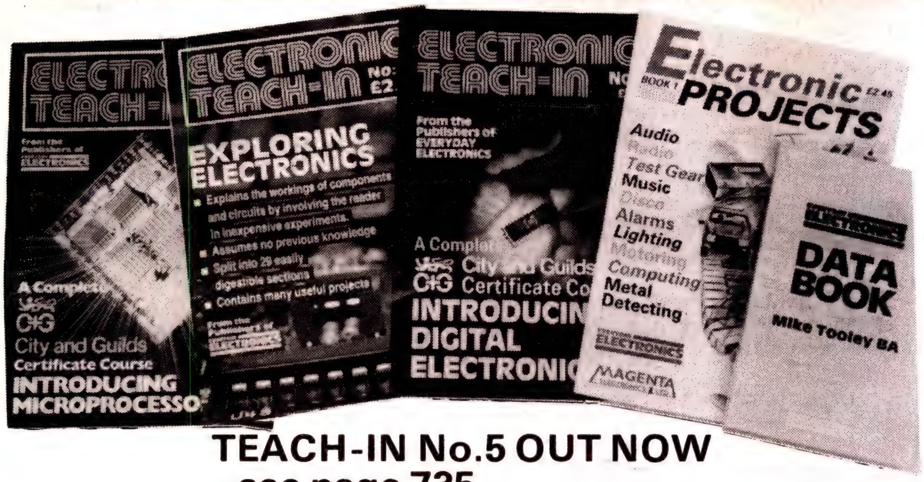
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The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components – resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

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Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

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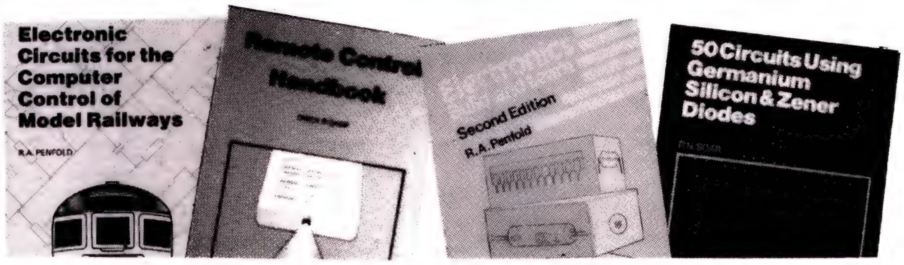
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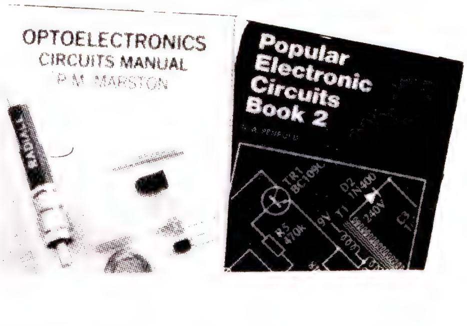

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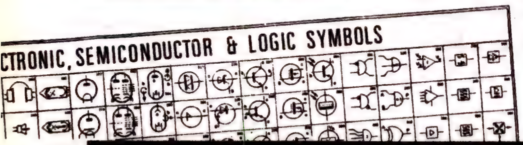

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HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available. Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.
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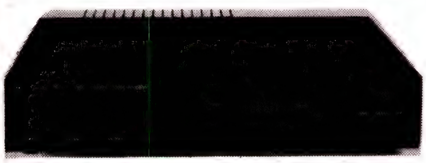
You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.
Our list will give you fuller details of all our Audio Kits, components and special offers.

AUDIO DESIGN 80 WATT POWER AMPLIFIER.



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance for a few tenths of the cost!. Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic:- "The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout." The standard amplifier comes with the option of a stereo LED power meter and a versatile passive front end giving switched inputs, and ALPS precision low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility. This means that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heatsink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component ident side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre-terminated, ready for instant use!. Remember with a HART KIT you get the performance you want at the price quoted through advanced circuit design, proper engineering design, and the right components. We do not insult your intelligence by offering a kit at what seems a fair price and then tell you that you have to spend twice as much to get an upgraded model!.

SPECIAL OFFER 10% OFF ALL COMPLETE KITS

RLH11 Reprints of latest 'Audio Design Amplifier' articles	£1.80
K1100CM HART Construction Manual with full parts lists	£4.50

Joining this amplifier now as a further option is the most advanced preamplifier ever offered on the kit, or indeed made-up marketplace. Facilities include separate tape signal selection to enable you to listen to one programme while recording another, class A headphone amplifier, cancellable 3-level tone controls and many other useful functions, all selected by high quality relays. For advance details see our list.

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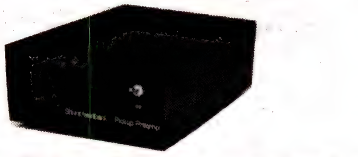
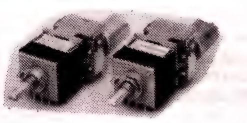


Modern, ultimate sound systems are evolving towards a built-in preamplifier within the turntable unit. This keeps noise pickup to a minimum. This new circuit by John Linsley Hood uses latest generation integrated circuits in the sonically preferred shunt feedback configuration to give an accurate and musical sound, with the ability to use moving magnet and moving coil cartridges. Power comes from two 9v PP3 size batteries or a mains power supply. See our lists for custom designed unit. This HART kit is exceptionally easy to build with very detailed instructions and all the specially selected components fitting directly on to the roller tinned fibreglass printed circuit board. Even the gold plated phono sockets mount directly on the board.

This Kit now comes with latest generation low-noise front end IC and onboard power stabilisers for any DC input voltage between 9v and 30v.

K1500 Special Discount Price for complete Kit	£67.99

ALPS PRECISION LOW-NOISE STEREO POTS.



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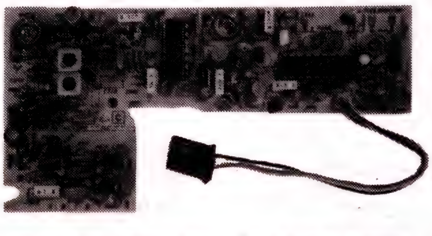
BARGAIN OFFERS

CAR RADIO FM IF STRIP WITH STEREO DECODER



Manufacturers overrun enables us to make this fantastic offer of ready built modules ideal for use with any of the above FM front ends. PCB carries IF amplifier with 10.7MHz ceramic filters, 2 transformer ratio detector, AX010 noise suppression IC and TCA 4500A advanced stereo decoder IC. Supplied complete with circuit diagram. (Available separately 40p).

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INF315 Data Sheet with full spec. and circuit diagram	35p

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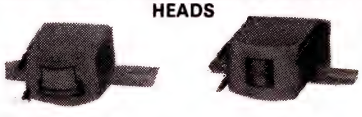
HIGH QUALITY REPLACEMENT CASSETTE HEADS



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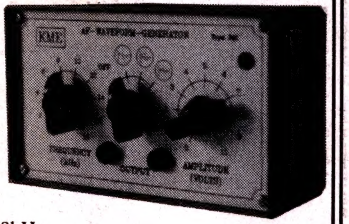

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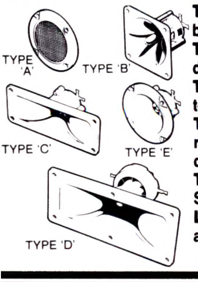

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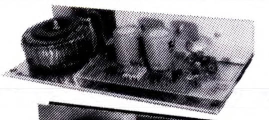
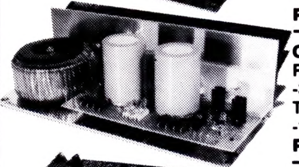


OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
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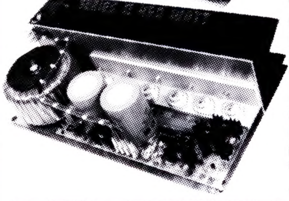
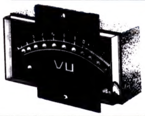


OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.



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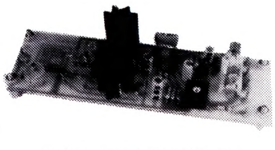

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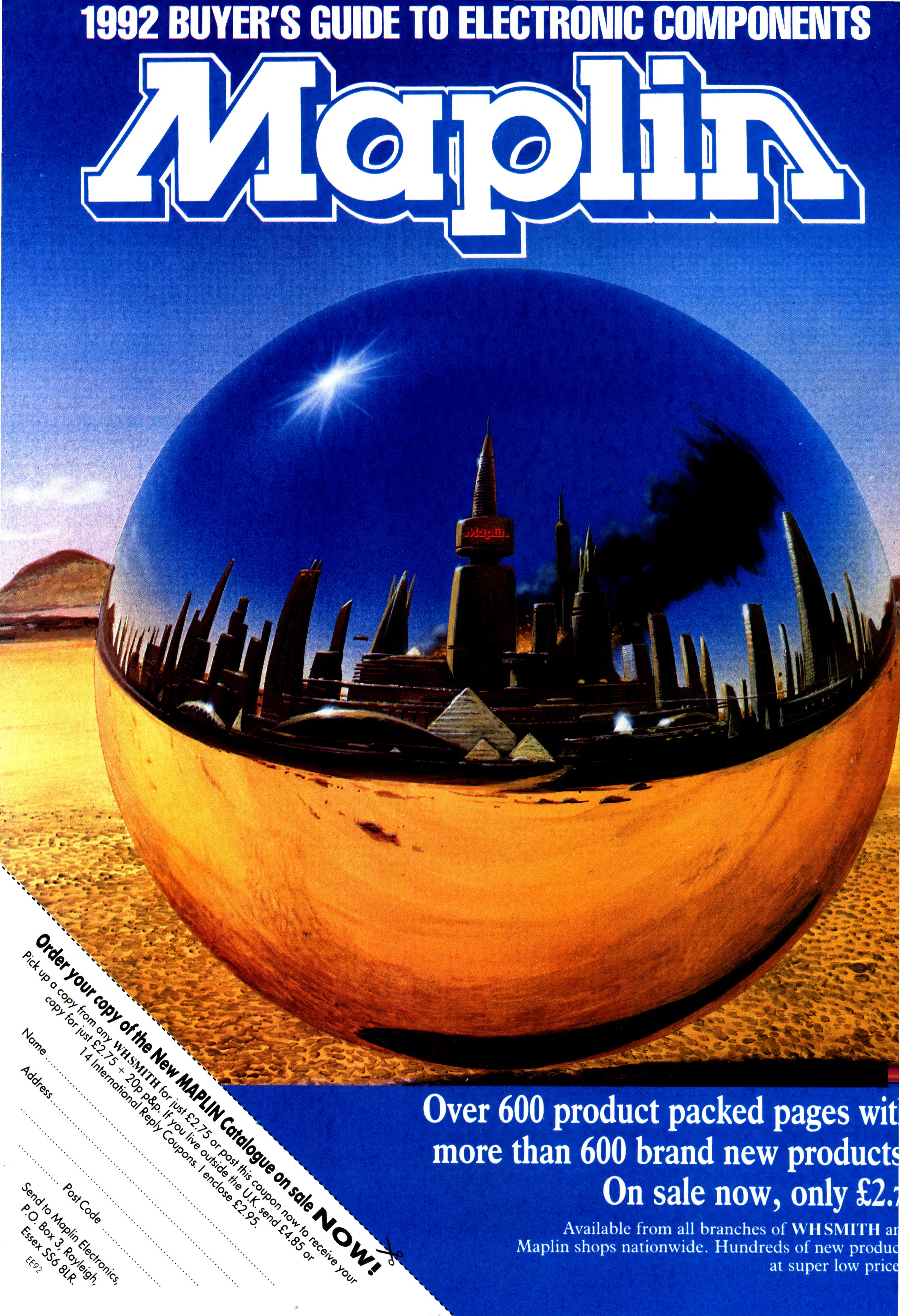

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